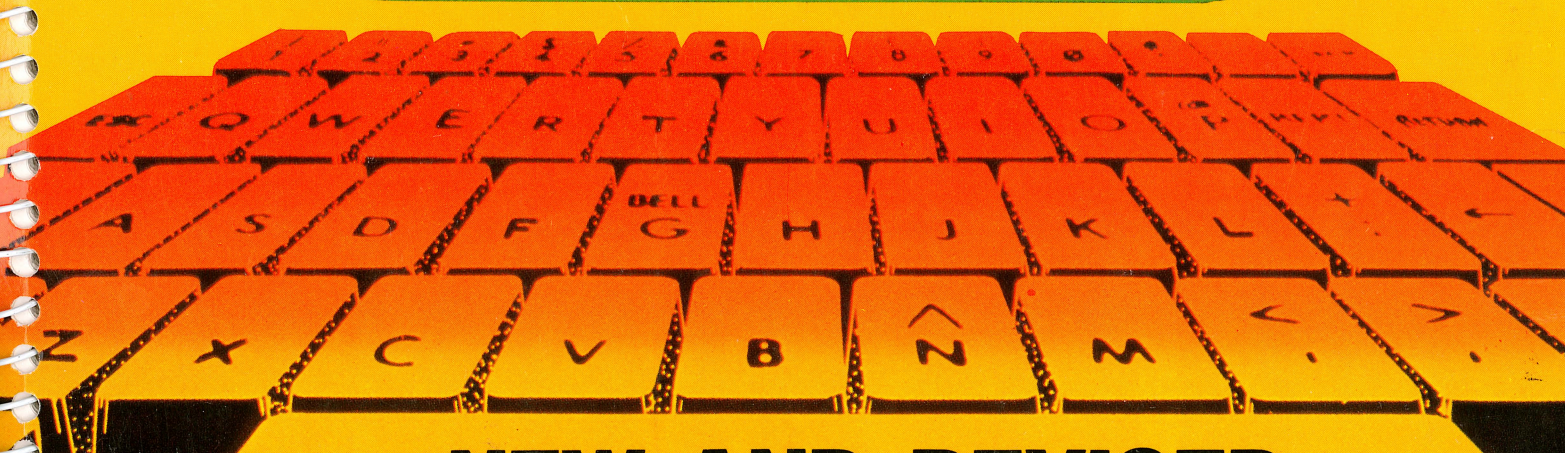


BY THE EDITORS OF CONSUMER GUIDE®

EASY-TO-UNDERSTAND GUIDE TO HOME COMPUTERS

- WHAT A COMPUTER CAN DO FOR YOU
- HOW YOU CAN USE A COMPUTER
- SELECTING SOFTWARE TO SERVE YOUR NEEDS
- COMPARING HOME COMPUTER SYSTEMS
- A BASIC INTRODUCTION TO PROGRAMMING



NEW AND REVISED

BY THE EDITORS OF CONSUMER GUIDE®

**EASY-TO-UNDERSTAND
GUIDE TO**

**HOME
COMPUTERS**

CONTENTS

CHAPTER 1

WHAT YOU CAN DO WITH YOUR OWN COMPUTER 4

A home computer is the ultimate jack-of-all-trades. It can play games, teach your kids, analyze your finances, and more. Here's a sample—the possibilities are almost endless.

CHAPTER 2

COMPUTER HARDWARE: THE POWER IN THE MACHINE. 12

Hardware is all the computer parts you can see and touch, like the keyboard, the video screen, and the circuitry that makes it work. Here's how all those components work together.

CHAPTER 3

SOFTWARE: THE KEY TO SUCCESSFUL COMPUTING 21

Software—called programs—is the instructions that tell the computer exactly what to do. Find out about the different types of magnetic media, and learn what software packages can do.

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Louis Weber, President
Publications International, Ltd.
3841 West Oakton Street
Skokie, Illinois 60076

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Manufactured in the United States of America
10 9 8 7 6 5 4 3 2 1

The prices listed in this book were accurate at the time of printing; prices are subject to change.

Library of Congress Catalog Card Number: 83-63594
ISBN: 0-88176-142-7

Writers: Forrest M. Mims, III, and Marc Stern
Design: Jeff Hapner and Barbara Clemens
Cover graphics: Quicksilver Assoc. Inc.
Illustrators: Clarence Moberg, Richard Flory
Photo credits: Apple Computer Inc.; Atari; Axiom Corp.; Coleco Industries, Inc.; Commodore Business Machines, Inc.; Epson America, Inc.; Hewlett-Packard; IBM Corp.; ID Systems Corp.; Intel Corp. (pp. 13, 86); Milliken Publishing Co.; NEC Home Electronics USA; Non-Linear Systems, Inc. (p. 60); Quasar; Spectra Video, Inc.; Tandy Corp./Radio Shack; Texas Instruments; Timex Computer Co.; Donna Preis and George Siede

CHAPTER 4	
PERIPHERALS: INCREASING YOUR COMPUTER'S POWER	33

To get the data in and out of your computer, you need peripherals—add-ons like printers and disk drives. Here's a look at some of the most important accessories for home computers.

CHAPTER 5	
CHOOSING YOUR HOME COMPUTER	48

Which computer is right for you? This survey of popular desktop and portable models will help you find a computer that fits your needs.

CHAPTER 6	
THE ABCs OF PROGRAMMING	67

You don't have to know how to program a home computer to use it, but you'll see that programming is easier than you think—and it can be fun!

CHAPTER 7	
THE FUTURE: WHAT'S AHEAD IN COMPUTERS?	81

Computers can do a lot today, but there's even more excitement predicted for the future. Take a look at what's coming tomorrow—and the next day.

BIBLIOGRAPHY: SELECTED PERIODICALS	88
---	-----------

GLOSSARY	90
---------------------------	-----------

INDEX	95
------------------------	-----------

WHAT YOU CAN DO WITH YOUR OWN COMPUTER



Computers! For many years, this word conjured up visions of huge, climate-controlled rooms filled with machines, blinking lights, and whirring tape drives. We used to think of people who use computers as an elite group, hunched over their glowing video displays like sorcerers toiling over bubbling cauldrons.

Now this vision of computers and the people who use them is changing. Certainly those huge mainframe computers will always have a place in business and government. They keep track of our income taxes and deductions, send out reminders that insurance premiums are due, figure our utility bills, and handle magazine subscriptions. It is difficult to imagine how our society could function today without them.

But suddenly, in the last few years, a new crop of computers has sprouted. The development of the microcomputer has radically changed the world of computing. Instead of ominous, room-sized boxes, these computers are friendly, personal information machines. They are affordable, automated servants that can help you keep track of your budget, figure your taxes, maintain your address files, process reports and letters, and even write your checks at the end of the month.

Hundreds of thousands of these personal or home computers have flooded the market during the last few years, making computing power available for an exceptionally low cost. Today's home computers, which can sell for under \$300—some are under \$100—have all the power of computers costing tens of thousands of dollars ten years ago. Today, almost anyone can buy a computer, take it home, plug it in, and bring computing power right into the living room.

WHAT IS A COMPUTER?

In a broad sense, we can consider anything containing a microprocessor to be a computer. A *microprocessor* contains thousands of microscopic circuits, or electronic connectors. It provides the real brainpower of the computer. This technological marvel—about the size of a fingernail—is a direct outgrowth of the miniaturization of electronic components developed for the space program. Today microprocessors can be found in many familiar products and places—in home and arcade video games,

microwave ovens, automobiles, supermarket checkout registers, and all the other automated servants we take for granted.

But what actually is a computer, how does it work, and what does it do? We could describe a computer as an electronic device capable of storing, retrieving, and processing information. However, calculators can do this, too, so we have to be more specific to define a computer.

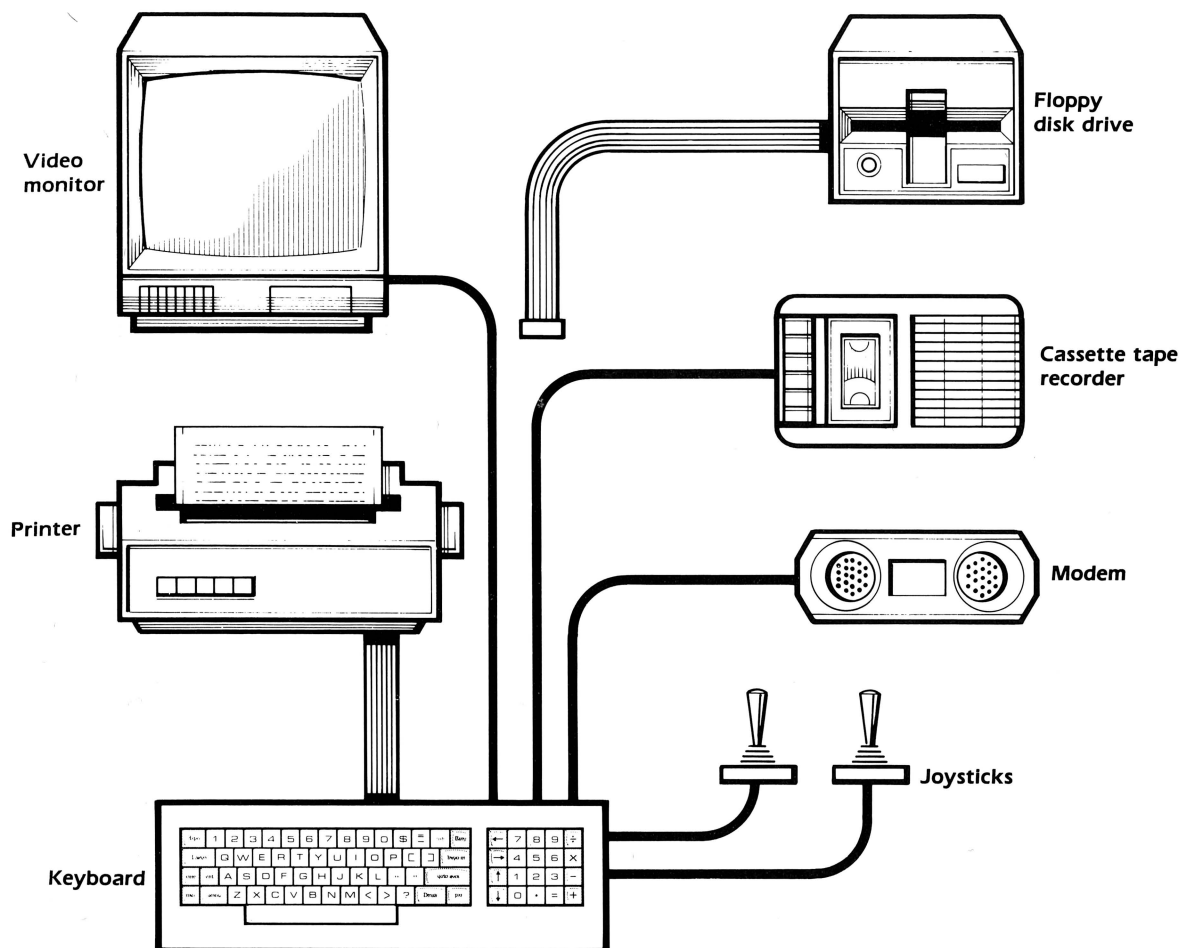
You can think of a computer as a device that takes a set or list of steps (called a *program*) and some information (called *data*) and automatically works on the information to produce new data. In this, the key word is *automatically*. On a simple level, this means the computer can do some figuring, if not actual thinking, on its own.

Although they look complicated, all computer operations can be boiled down to four functions. Whatever their size, all computers use an *input* device for getting information in, a *processor* for working on the information, *memory* to store the information, and an *output* device for getting the new information out to you. Of course, there's more to computers than that. But once you know the basics, it's easy to fill in the details.

Two basic terms you commonly hear when people talk about computers are *hardware* and *software*. You may be somewhat familiar with their meanings. *Hardware* is the equipment—any part of the computer system you can see and touch. The keyboard, the microprocessor, the video display screen, and accessories like cassette tape recorders and printers are all examples of hardware. *Software* is the electronically coded instructions that tell a computer what to do. Although software is hard to visualize, it is the most important part of the computer system. Without it, the computer hardware is helpless. Software makes the system function. Software is usually packaged on cassette tapes, floppy disks, or plug-in cartridges, or it can be written by the user. We will more fully discuss hardware and software in Chapters 2 and 3.

TYPES OF COMPUTERS

There are now many types and sizes of computers on the market: the *mainframe* computers



A computer system often includes accessories called peripherals—the video monitor and printer to get information out, the joysticks to put it in, the disk drive and other devices to move information both ways.

used by large businesses, the government, and universities; the *minicomputers*, which are really just smaller versions of mainframes; and *microcomputers*, which are more commonly called home or personal computers. These microcomputers are the computers we will be talking about in this book. One aspect of microcomputers that distinguishes them from minis and mainframes is that only one person uses them at a time—that's where the term *personal computer* first came from. The huge business computers can be used by hundreds of people at once.

Recently, there has been a trend toward differentiating among the terms used for the various types of microcomputers. *Home computer* usually refers to an inexpensive computer that can attach to a television set and is used for game, educational, and home management software.

The *personal computer* is a moderately priced machine that can be used at home or in an office to do word processing and financial analyses, play games, and maintain household and business records. The *professional computer* is a top-of-the-line model that is usually purchased for office management rather than home use. Remember, however, that there is a great deal of overlap among these terms.

Microcomputers come in various sizes. *Desktop* computers usually have a typewriter-style keyboard, a main chassis that contains the actual computer electronics, and a video display screen that lets the computer communicate with you by displaying words or pictures on the screen. Some of these computers allow you to use your home TV as a video display; you simply connect the computer to the TV and you're ready to compute. Most computers also

have a number of accessories—called *peripherals*—such as printers for getting information on paper and cassette tape recorders or floppy disk drives for storing data.

A variation of the microcomputer is the *portable* computer. It has all the power of a desktop version but comes packed in a take-along case the size of a sewing machine or is small enough to fit in a briefcase. Portables are rapidly gaining popularity.

The smallest variation of the microcomputer is the *handheld* or *pocket* computer. These computers bear their name because they fit in a pocket and can be used in the palm of a hand, just like a trusty calculator. But, unlike calculators, they have real computing power. Some of them can even be programmed to produce graphics on the display. They do have a few limitations, but they're powerful for their size.

In this book we will describe all these types and sizes of microcomputers. We will discuss what can be done with them and how to choose a computer that will accomplish what you want a computer to do for you. Today's home computers are vastly different from those room-sized monsters. Once you learn to use a micro, you'll wonder how you ever got along without it.

WHAT YOU CAN DO WITH A HOME COMPUTER

Although home computer prices have fallen dramatically in the past few years, they still



A typical desktop computer is a keyboard console that hooks up to a TV or monitor for video display.



Handheld computers have real computing power and can even be hooked up to peripherals like printers and modems.

can require a sizable investment. Some basic computers are available for less than \$100. A moderately priced and more versatile machine can cost from \$200 to \$1000. An advanced system designed for business and professional office use may cost anywhere from \$1000 to \$5000 or more. Remember that these costs often are for the basic computer only (including the keyboard and the main chassis). Other equipment like a printer, a video display, or a cassette recorder or disk drive can add to the cost. So, even though your initial investment need only be about the same as the cost of a black-and-white television set, in order to do much with a computer, you may have to spend considerably more than the basic price to set up the computer system you need.

It is useful, then, to ask why you want a computer and what you intend to do with it. (These are probably the first questions you will be asked when you talk with computer salespeople.) Your answer may simply be that you are curious about computers, or you may have a specific purpose in mind. Of course, there are many possible answers to these questions. A computer is an electronic jack-of-all-trades. It can replace paper, pencils, chalkboards, typewriters, filing cabinets, and address books. It can compete with both television and backgammon for entertainment. It can regulate household energy consumption as well as a clothing budget or teach French and mathematics to you or your children. Through a telephone line, a home computer can let you carry on an extensive correspondence with fellow high-techers without ever buying a stamp, order a year's supply of linen and paper products without having to push a cart down an aisle, or plan a vacation from your easy chair.

Just as importantly, personal computers are a link with tomorrow. They can tune you into the global high-tech world of the future. In the next few pages, we'll offer an overview of what home computers can do and why you may want to make one a part of your life.

Your Household Problem Solver

In many ways, running a household is like running a small business. Money is brought in and paid out, equipment such as cars and appliances is invested in, taxes are paid, and some form of inventory is kept. Like any good business, a family should have an efficient way of managing this activity, and a home computer easily fills this need.

A home computer can balance your checkbook, compare actual and budgeted expenses, keep an inventory of groceries, help you plan your menus, and figure Uncle Sam's bite at the end of the year. You can keep an updated list of your belongings or a roster of the members of your club; the computer will find individual items at lightning speed, and even sort the lists.

Although computerizing records and finances might seem like more trouble than it's worth, you may find that a home computer can actually save you money. In some cases, the savings can pay for the computer in a year or two. Already many household appliances such as automatic thermostats, water heaters, electric stoves, and others have built-in micro-processors to make them work more efficiently. In the near future, computers will probably result in additional savings by controlling home energy use. Someday, your entire home may be wired into a central home computer that not only will watch energy use, but also will act as a fire and burglar alarm. If this sounds like science fiction, it isn't. Several universities already have experimental homes that use computers in this manner.

Education: Your Personal Tutor

The educational possibilities of home computers—for adults as well as children—are almost unlimited. Students are acquiring some computer literacy at school, and children take to computers with none of the technical timidity that may plague their parents.



Children learn fast and stay interested with the computer's electronic teaching. A computer tutor makes learning fun.

Noting how children become intensely involved in video games, educational software developers are writing programs that encourage this same kind of involvement in learning. These electronic educators take advantage of the computer's capacity for interaction—instantaneous two-way communication—to design programs that teach math, reading, and science.

Children can use home computers as personal tutors, which lead them step by step through a subject and let them learn at an individual pace. Many educational programs use an electronic-game format to keep the children interested and alert. Fast action, coupled with lots of colorful graphics and sound effects, can keep even the most reluctant learner involved and interested.

These electronic tutors have already found a place in the school. And a computer at home to go along with the school's system can speed up the learning process even more.

Adults can take advantage of instructional computing, too. Advanced educational software is becoming available for students up through the college level, a boon for busy homemakers and professionals wanting to

broaden their educations. Computers are particularly appropriate for learning a foreign language, reviewing mathematics, or mastering basic accounting. Review courses for professional tests are being developed for many computers, and some of these are interactive, allowing for immediate feedback on the learner's progress.

Some visionaries foresee a day when a great deal of the training and educating that goes on in this country, particularly for adults, will be done via computer. For learning in which the social aspects of the classroom are not vital, the computer can become a helpful and efficient tutor.

Computer Games

No discussion of home computers would be complete without mentioning games. Many home computers are purchased especially for this purpose, but their owners often soon find other, more practical applications. Whatever your age or background, games are a terrific introduction to computers. Even if you are buying one for more "serious" applications, you'll probably end up buying a game or two as well.

There are literally hundreds of home computer games available today. Most use even more color and advanced graphics than those that are made for home video game systems. In fact, many computer games come close to the realism of arcade games. And best of all, you don't have to leave home or stop when you run out of quarters.

Word Processing

An increasingly popular use for computers, both in homes and offices, is word processing. An example of word processing that everyone is familiar with is the "personal" letters we receive (perhaps too frequently) from mail-order firms, politicians, credit card companies, magazine publishers, and the like. All these letters were typed by computers that automatically inserted a name, address, and occasionally other personal information at appropriate points in the letter. The same letter—similarly personalized—may well have been mailed to hundreds of thousands of people. But producing form

letters is only one example of what word processing can do.

Word processing enables a computer to be used as an advanced typewriter, with the video display a piece of electronic paper. The manuscript for this book, for example, was written on a home computer using word processing software. Word processing offers many advantages over old-fashioned typing. It enables you to write—and rewrite—letters and reports, make numerous revisions, and print out error-free copies—even if you never took a typing class. This is particularly useful for term papers and business reports. If you are involved with civic, social, or political groups, word processing and mailing list software let you automatically send form letters or newsletters to fellow members.

Although you might ask what advantage there is to seeing your words on the screen—you still have to have a printer to make a final copy—word processing has many advantages. You can move words, phrases, sentences, and paragraphs around, putting them exactly where you want them. You can take out words or whole sections; the spaces automatically close up. When your letter or report is in exactly the form you want, you press a button and print it out on paper. Not a bad way to write a term paper! You can even do your own personalized letters to a long list of people, or you can send a newsletter to everyone in the family.

If you're hesitant about using word processing because you don't know how to type, there are software programs that teach touch-typing. You can also buy programs that check spelling by comparing all the words in what you've written with entries in an electronic dictionary. There are even programs that check some points of grammar.

A home computer used as a word processor can be a real time-saver, even if it's used only occasionally. If you do lots of writing, you may wonder how you ever managed without the convenience of word processing. Not all home computers, however, can handle word processing efficiently. If this will be an important application for you, carefully consider the word processing software packages available before you start shopping for a computer. Then you can choose a computer system with the capabilities to handle your word processing needs.



Computers are helping even the smallest businesses keep track of inventories and financial records.

Software For Business

Recently personal computers have become more common in business offices, not only to replace some functions of a mainframe, but to solve problems and keep records in small businesses that could not afford computers before. Today, whether you run a small business at home, are a professional such as a lawyer or dentist, manage a small company, or run a large farm, you will find that a personal computer can save both time and money. It will keep better track of things, which is worthwhile in any business.

If you visit a computer store, you will see more computer systems and programs designed for business than for any other application. Although some low-cost home computers can be used in business, many of the more expensive personal computers are specifically designed for business use: they have extra memory, larger keyboards, clear and wide video displays, and other features useful for business applications. Of course, these extras do cost more, but the expense may be worth it to you. If you are thinking of using a computer for both personal and business use, be sure to look at business systems before making a buying decision.

Your Personal Investment Advisor

With a home computer, you can quickly review investment options to help you decide

where you should put your money, from banks to money market funds to real estate. A calculator can do this, too, but you will generate a lot more paper to accomplish the task, and probably take a lot more time. A computer can do away with all that, displaying on a video screen a well-organized comparison of investment plans. Further, it can do complicated analyses that would take you hours even with a calculator.

Some home computer users get up-to-the-minute reports on stocks and bonds by hooking their computers up to computer information utilities—the Dow Jones News/Retrieval Service, for instance—through the telephone lines. A home computer can get you all the information you need, spot trends, and make investment suggestions, for the kind of financial guidance only the pros could give you a few years ago.

Your Window on the World

Home computers can also broaden your horizons by letting you obtain information on a wide variety of subjects. Using a special device called a *modem*, you can hook your machine to the phone lines and explore the world of *telecomputing*, linking your computer with huge computer databases all over the country or the world. Besides the investment information already mentioned, computer information services like The Source and CompuServe provide the latest news and weather. They let you exchange electronic mail (rather like CB or ham



A modem lets you hook your home computer into a telephone line to communicate with other computers.

radio operators) with other computer users around the country. We may all soon make travel reservations from the comfort of our homes without going through an airline clerk, browse through nationwide classified ads, and do our shopping by electronic mail.

What about expense? To gain access to these databases, you first need to pay a registration fee, which can cost from about \$40 up to \$100. Then you pay for the time you are actually hooked up to use the service. These services can cost anywhere from about \$6 to \$70 an hour, depending on the service and the time of day (evenings—or the middle of the night—are much less expensive). There may not even be a long-distance telephone charge because the companies that maintain these databases have telephone lines all over the country. From most metropolitan areas, hooking into one of these information depositories is almost as simple as dialing a friend. Just dial the local phone number, give the information service computer your personal password, and you're on your way.

And Lots More

Any list of what a home computer can do is almost endless. If you have been interested but wary of getting involved, fear not! Today's home computers are *user friendly*, which simply means that they are easy to use. You don't have to learn how to program. Commercial ready-to-run software is available for all the purposes we have talked about and many more. Most of these programs need only be plugged into the computer and they are ready to go. And most programs give you instructions right on the screen that lead you step by step through the program.

LEARNING MORE ABOUT COMPUTERS

If you have read this far, you are already interested in becoming part of the world of computing. The first step to getting involved is educating yourself. This book is designed to

give you a background in home computers that will help you feel comfortable when you first enter a computer store.

Plenty of additional information is available from other sources, too. Purchase or subscribe to computer magazines. (A selected list of these periodicals is included at the back of this book.) Many computer magazines are now available in the local grocery store. Join a local computer club or users' group. Get to know people who own and operate home computers, and send for information and brochures from computer manufacturers. Most colleges and some computer stores offer excellent courses designed for beginners. Many offer more specialized courses on hardware or programming, and some courses teach you to use specific software programs. After acquiring some computer education, you may even find you want to move your career into a computer-related area. It is an expanding and exciting field!

Another way to learn about personal computers is to use them. Nothing beats hands-on experience, and it's a great way to get an idea of which computer is best for you. Most computer stores will be glad to give you a chance to try out various models of computers.

Computer camps are another way to learn. Although the first such camps were designed for children only, adult camps are beginning to spring up all over—from the mountains to tropical islands. This is an interesting way to combine a vacation with some highly practical education, although at a rather high price.

Computers are here to stay. They have become so much a part of our society that we now wonder how we lived without them. The best advice we can offer is for you to get involved with home computers now. Your knowledge of computers will give you valuable experience at home and probably at your job as well. You will learn firsthand how we'll live in the years ahead. It might seem a little confusing at first, but the confusion won't last long once you get started. Don't wait to take advantage of the exciting world of computers.

COMPUTER HARDWARE: THE POWER IN THE MACHINE



In this chapter, we will explain the basics of computer hardware. Along the way, we'll tell you a little about how a computer works. To do this, we will need to explain terms like *operating system*, *RAM*, and *ROM*. Like any specialty, the computer world has its own language. Although we'll try to keep the jargon to a minimum, it's important for you to understand some basic terms because knowing them will help you make an informed decision about buying a computer.

Remember that *hardware* is the physical components of the computer system—the electronic circuitry, video display, keyboard, disk drive, and other equipment. Any equipment or accessories beyond the basic computer itself are called *peripherals* in the computer world. *Software* is the instructions (in the form of electrical signals) that tell the computer what to do. We'll talk more about software in Chapter 3. Though we'll talk about some peripherals in this chapter, they'll be discussed more fully in Chapter 4.

As we said earlier, computer hardware has four main elements: the microprocessor, memory, input, and output. All computers have these four basic elements, regardless of their size or power—whether it's the Social Security Administration's mainframe or the small handheld microcomputer a salesperson carries in a briefcase. An input device—a keyboard, for instance—is responsible for getting information into the computer. The microprocessor works on the information. Memory stores the information. An output device, like a video display screen, gets the processed information out to you. Let's take a closer look at how these four elements work.

THE MICROPROCESSOR

Without the microprocessor, there would have been no home computer revolution. It is the brains of your computer, the electronic circuitry that does the actual computing. An amazing fact about the microprocessor is that all its power is on a tiny chip of silicon made from purified beach sand. This device is no bigger than the fingernail of your index finger, yet it holds tens of thousands of microscopic transistors arranged in a complex maze. These transistors are electronic devices that control the flow of current. They are capable of working at

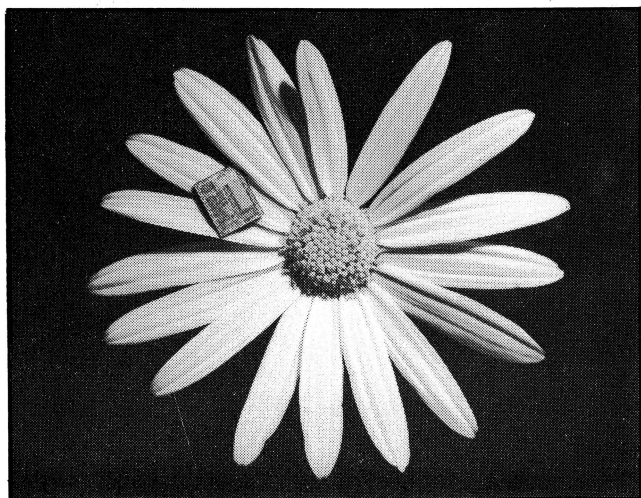
blinding speed—millions of times per second.

Another surprising fact about the microprocessor is that it understands only two things: the digits 0 and 1. This two-digit system is called the binary numbering system. The microprocessor gets all of its information in a continuous stream of *bits* (BInary digITS) that register data according to voltage. If voltage is present it's a one; if voltage isn't present it's a zero.

To use a computer, it isn't necessary for you to know how a microprocessor works, but you should be aware that there are a number of different types of microprocessor chips. The most common ones are the Z-80, the 6502, the 8086, and the 8088. The Z-80 is the most popular for home computer use, although the 8088 is beginning to run a close second. These are brand names, and each brand has different advantages and disadvantages. Since these microprocessor chips are very much alike and since they all do essentially the same thing, the particular brand isn't an important concern for the home computer user.

Of more importance than the brand name is the size of the microprocessor. The size tells you how big a chunk of information—how many bits—the microprocessor can handle at one time.

Home computers usually come with either 8-bit or 16-bit microprocessors. Recall the description of what a bit is—either a one or a zero, a charge or no charge. If a microprocessor could handle information only one bit at a time, it



The microprocessor chip, so tiny it's dwarfed by a daisy, is etched with thousands of electronic circuits.

could not instantaneously do even simple tasks such as adding $2 + 2$.

About ten years ago, the early microprocessors handled information in 4-bit chunks (for instance 1001), but their usefulness was limited to such chores as doing the calculating for desktop calculators. Then the 8-bit microprocessor was developed. This handled twice the information at a time. Introduced around 1975, the 8-bit microprocessor quickly became the industry standard for home computers. That 8-bit chunk of data brings us to some other terms you'll hear frequently. In computerese, 8 bits of information is called a *byte*; 4 bits is called a *nibble*.

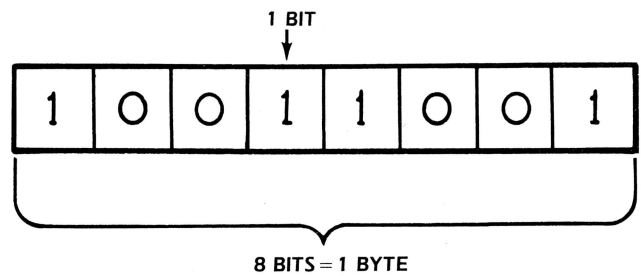
Now, the industry is rapidly changing again with the development of the 16-bit microprocessor. Today, some microcomputers use 16-bit rather than 8-bit microprocessors. Since a 16-bit microprocessor can handle twice the amount of data at one time, it is about twice as fast as an 8-bit device. Further, its internal structure is such that it can do more things with the data it has been given. A 16-bit machine handles information in 2-byte chunks, rather than in 1-byte chunks. Thus, it can handle more complex tasks in the same time it takes an 8-bit machine to handle simpler tasks.

All of this is a natural trend. Just as the industry moved from 4 to 8 bits, it is now moving from 8 to 16 bits. The 16-bit microprocessor has other advantages, too. For instance, it can handle much more memory than the 8-bit device. Although the 16-bit microprocessor has many advantages for business and professional computing, the 8-bit microprocessor is still sufficient for the home computer user.

MEMORY

Although the microprocessor is an essential component, all the parts must work together to make a functioning computer. A microprocessor needs a place to store instructions, information, and the results of its computations. That's where memory comes in. Without this storage area, the computer could not "remember," for instance, what number to add to what other number.

If you could look into the cabinet protecting your computer, you would see an array of



Computers handle information in units called bytes. A byte is a chunk of eight bits—the binary digits 0 and 1.

chips—the tiny black boxes that hold all the microscopic circuitry. The largest box is usually the microprocessor, but there are other chips, too, normally lined up in a row. This is the computer's internal memory. Each chip contains thousands of simple on/off switches, which are used to store binary information (1 = on; 0 = off). The thousands of switch combinations are the actual program the microprocessor works on.

There are three types of memory. *Random-access memory* (RAM) handles instructions and information you give the computer, which can later be erased. *Read-only memory* (ROM) contains permanently stored instructions that the computer requires to do its basic, routine operations. *External mass storage* is the means of storing the information you want to save (such as with cassette tapes or floppy disks, which we'll explain in the next chapter). Here we will consider RAM and ROM.

RAM: The Electronic Scratch Pad

The memory the computer uses to obey the instructions you give it is called *RAM*, for *random-access memory*. Actually, random-access memory is a bit of a misnomer. A better name for it would be read/write memory, because information can either be *read* from it or *written* to it (put into it) by electrically changing the microscopic switches from on to off, or vice versa. "Writing to RAM" is done when you enter or *load* a program into the computer. The microprocessor also writes or stores the results of its computations there.

It might be helpful to think of RAM as a series of post office boxes. At any given time, an individual box might or might not have information in it. If you consider an empty post office

box to be a 0 and a full post office box to be a 1, you'll get an idea of how RAM works.

One of the most important things to remember about RAM is that when you turn off your computer, the information stored in RAM disappears. That's because these chips require electrical current in order to retain information. If the current to the memory chips is turned off, the information stored there is lost. This is why it is important to have some form of external storage that doesn't disappear, such as cassette tapes or floppy disks.

Because RAM memory can lose its information, it is referred to as *volatile* memory. Memory that retains its contents (as with ROM, cartridges, tapes, and disks) is called *nonvolatile* memory.

How Much Ram Is Enough? How much RAM you need is another consideration you will have to keep in mind when buying a computer. All programs must be loaded into RAM in order to run. The longer and more complicated the program is, the more RAM it requires. If your computer doesn't have enough RAM for certain programs, then it can't run them.

The standard measure of computer memory size is a *kilobyte*, called a *K* for short. You might assume that a kilobyte is 1,000 bytes, since the prefix *kilo* means 1,000. But in computers, a *K* is actually 1,024 bytes. (Remember, a byte is an 8-bit chunk, or 8 individual on/off switches.) To give you an idea of how much space a *K* is, consider this. If you took a typical double-spaced typewritten page and turned each letter, number, punctuation mark, and space—because even spaces need a memory location—into the binary code of 1s and 0s the computer works with, that page would fill about 2K of memory. From this you could figure that 8 of those typed pages would fill 16K of memory, 16 of those pages would fill 32K of memory, and so on.

Different home computer models come with different amounts of built-in RAM. Common sizes are 16K, 32K, 48K, and 64K of RAM (although some models have as little as 2K and others have more than 64K).

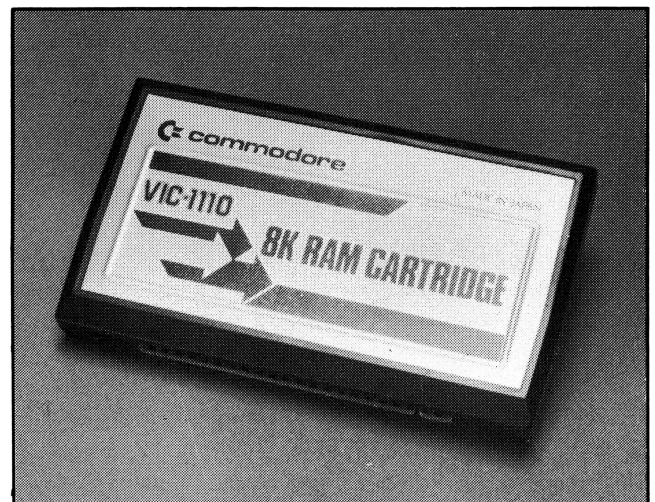
How do you decide how much RAM you need? The memory size you need depends on what you want to do with your computer. The

greater the amount of data you want to work with and the more complex the tasks you want to perform, the greater amount of memory you need. Some educational programs, games, and simple home finance programs require only small amounts of memory. More complex programs may require a great deal more.

A good way to help you decide how much memory you need is to look at the kinds of software programs you want to use and see how much memory they require. (The amount of memory required to run a software program is indicated on the package.) For example, do you want a simple word processing program for handling letters and short reports, or do you need more complex word processing for extensive business use or for writing the great American novel? The tasks you want your computer to perform will help you determine the amount of RAM you need.

Adding Memory. Regardless of the amount of memory you start out with, most home computers allow you to add more memory later on. In some cases, this is as simple as plugging in a cartridge or an additional circuit board; in others, you have to return your computer to a service center to have memory added.

Since the amount of memory you can add varies from model to model, you should be aware of the maximum amount a computer can handle before you buy. Many of today's home computers can be expanded to as much as 64K or more of RAM. Adding memory to a computer adds to the cost, but it can be a good



For some computers, adding memory is as simple as plugging a cartridge into a slot.

investment. You should also be aware that many of the more advanced software programs on the market need as much as 64K of RAM. We'll further discuss adding memory in Chapter 4, "Peripherals."

ROM: Internal Operating Instructions

The other kind of memory contained in a home computer is *ROM*, or *read-only memory*. This memory holds the built-in operating instructions used by the computer. As its name implies, information can only be read from ROM, not written to it.

ROM chips have their information permanently installed when they are manufactured. The microscopic on/off switches are set and the information in ROM can never be altered. ROM also is nonvolatile memory; the information in ROM cannot be lost when the power is turned off. Some manufacturers tell you how much ROM is installed in their systems, but this really isn't an important buying consideration.

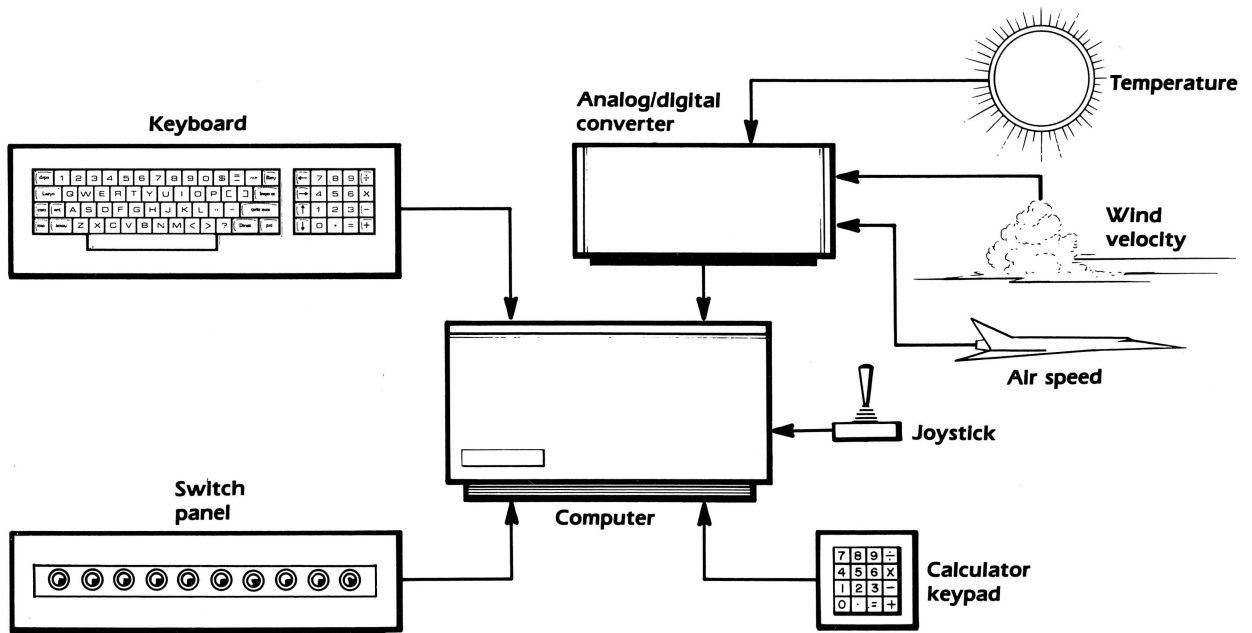
ROM serves many essential functions. Every time a computer is turned on, it must be told

how to start itself. This short instruction program—often called the *bootstrap* routine—tells the computer how to set itself up to start operating. It also has the computer perform a number of automatic checks to make sure the circuits are in working order.

Nearly every home computer also comes with a programming language called BASIC built into ROM. The BASIC language allows you to communicate easily with your computer. Because the computer needs to know BASIC to understand commands given to it in that language, this knowledge is stored permanently in ROM. This way, you can do certain things with your computer as soon as you turn it on. You don't have to load a program from a cartridge, tape, or disk every time you want to use the computer.

INPUT DEVICES

Without a way to get information into and out of your computer, the machine would be very much like a human brain without any of the five senses—potentially smart, but practically helpless. *Input* is putting information in, and there are several ways to do this.



A variety of input devices can feed information into your computer—a keyboard, a joystick, a calculator keypad. An analog/digital converter changes variable information, like temperature, into signals the computer understands.



A computer keyboard has the standard typewriter keys, as well as specialized keys that perform various computer functions.

The Keyboard

The most common device for inputting information is a typewriter-like keyboard. It enables you to give instructions to the computer. Every time you press one of the keys, a special binary code consisting of a combination of voltage/no-voltage pulses—1s and 0s—is generated. The microprocessor chip interprets your instructions and acts on them.

Computer keyboards differ somewhat from most standard typewriter keyboards. Computer keyboards have the normal letter, number, and punctuation keys, but they also have some other keys marked with terms such as ESCAPE, BREAK, and CONTROL. These produce special codes that tell your computer to perform certain tasks. For example, the BREAK key tells the microprocessor to stop what it's doing and wait for further information from the keyboard.

Many keyboards also have separate numeric keypads, with the numbers arranged as they are on a calculator keyboard. While a numeric keypad isn't a necessity, it is handy if you'll be using a computer for a lot of numerical tasks.

Another important computer keyboard feature is the keys with arrows pointing left, right, up, and down. They are called *cursor control keys* because they control the movement of the *cursor*, a movable indicator on the screen. The cursor may be a blinking line or a small blinking square. The cursor is like a bookmark; it shows you where you are on the screen and marks

your place. If you want to change a letter in a word or change a line in a program you have written, the cursor lets you pinpoint the location of this change for the computer. All you have to do is press the arrow keys to move the cursor to wherever you want to make the change.

On most home computer systems, there are some keys that serve more than one purpose. For example, many home computers have graphics keys, which let you create various shapes—squares, rectangles, and other forms—on the screen. The shapes can be strung together to produce graphs or drawings. On most home computers, the character keys—those with letters of the alphabet or numbers—are also the graphics keys. By giving the computer a command, these letter or number keys can be shifted into their graphics mode, much like depressing the shift key on a typewriter to produce uppercase letters.

Kinds of Computer Keyboards. Over the past few years, several kinds of computer keyboards have come on the market. Some of these are substantially different from the standard typewriter keyboard. Since the computer keyboard's function is to pass electronic pulses into the computer's processing unit, rather than to directly cause letters and numbers to be printed on a page, computer manufacturers have been able to experiment with some variations in design.

One of these variations is the *chiclet keyboard*, so called because the small plastic keys resemble that brand of chewing gum. A chiclet keyboard is touch sensitive; striking one of these keys causes an electrical connection to be made in the computer. Though good for small hands, these keyboards can be awkward for some adults to use. The action of chiclet keys may also seem somewhat stiff to experienced touch-typists.

Another variation is the *membrane keyboard*, a flat plastic pressure-sensitive sheet imprinted with key names and labels, like those used on some cash registers. Membrane keyboards have the advantage of not allowing dirt or food to fall into the keyboard, and thus they are good for computers used by young children. Membrane keyboards are usually awkward for tasks that require a lot of typing such as word processing, particularly for good typists. Mem-

brane keyboards have been used on many lower-priced computers.

Keyboards resembling the standard typewriter version are more popular with most computer users. Their full-stroke action and full size take no getting used to by experienced typists. Keyboards that vary from the standard "QWERTY" arrangement of a typewriter keyboard have not been well accepted, and typewriter-style keyboards are again becoming the norm for computers.

Some computer keyboards have more than the typewriter's standard 50 keys. Some include a numeric keypad for calculations. Other models have function keys for one-stroke entry of commands or instructions to the computer, such as RUN, PRINT, LIST, and so on. Some computer keyboards even have an international character set, which allows for special symbols and alphabets, such as the Greek letters commonly used in mathematics.

Other Input Devices

While the keyboard is the most common way of giving information or instructions to the computer, there are other ways as well. If you'll be using your computer to play fast-action video games, you may use a joystick, game paddles, or a trackball.

A *joystick* is a lever that moves in all directions, something like the control stick of an airplane. It lets you move a spacecraft or some other object on the video screen fast enough to shoot down alien invaders and save the earth from green meanies. The *trackball* is a round, ball-like object that you rotate with your fingers. It lets you quickly move that spacecraft around the screen in all directions. A *paddle* is a small knob or dial that you turn to move an object in only two directions on the screen. If you plan to use your computer to play a lot of games, you may want one or more of these devices. In addition to games, there are now many other types of programs that use a joystick for input. All of these controllers are relatively low-cost options that plug right into your computer.

There are other specialized input devices that let you move the cursor or another figure around the screen without using the keyboard. One such device is called a *mouse*. When you

move the mouse on a table or a special surface, the cursor makes corresponding movements on the screen. A few computers and programs let you use such a device to select specific activities within a program simply by moving the cursor onto a word or a picture that represents the task you want to perform.

A *light pen* is also used in some programs to select an activity or to answer questions. A light pen is connected by a cable to the computer. You can point the light pen directly to a word or picture on the screen to tell the computer what you want it to do. Light pens are used for some educational programs designed for children too young to read or to type words on the keyboard. Light pens can also be used to draw graphics on the screen. They are discussed more thoroughly in Chapter 4, "Peripherals."

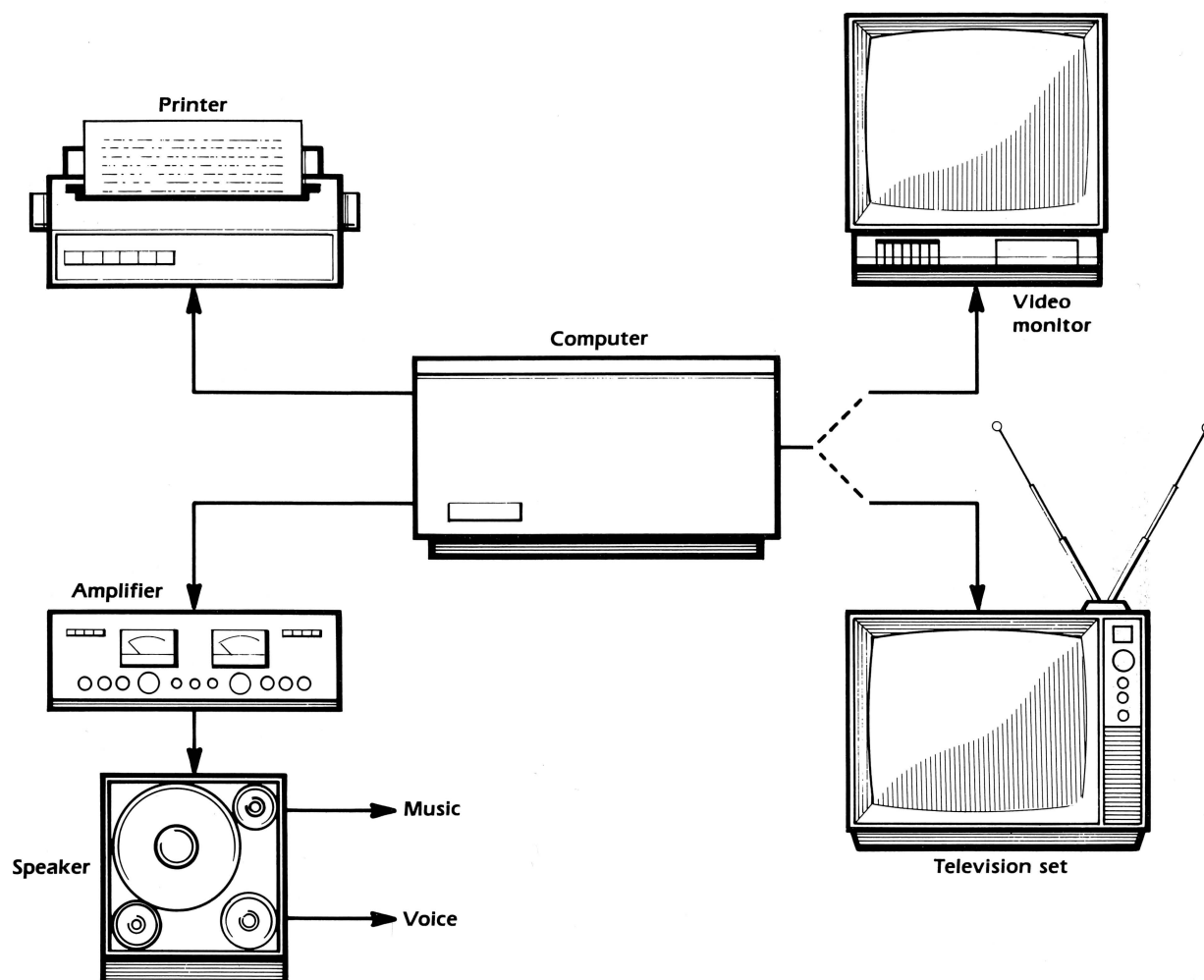
Now it is even possible to tell the computer what to do simply by touching the screen with your finger. A recent development lets you select a task you want performed or point to text you want to move, just as you might with a light pen, except the only device you need is your own hand.

There are other input devices for specialized uses. Among them are *analog/digital converters*, or A/D converters for short. A/D converters take measurements (like room temperature) and convert them into binary signals (0s and 1s) a computer understands. The use of such devices is becoming more widespread, because they enable you to control your home appliances and lights right from the computer.

Another, still experimental, device gives a computer voice recognition capabilities. Someday, you'll be able to give your computer instructions just by speaking to it. Voice recognition devices are currently available for a few machines, but they are extremely expensive, and they are capable of understanding only a limited number of spoken words.

OUTPUT DEVICES

Now that we've looked briefly at what goes on inside a computer and at ways of communicating with a computer, the next question is: How does the computer get the information



The most common output device is the video display—either a special video monitor or your own TV. You can also get written output, with a printer—or audio output, with an amplifier and speaker.

out to you? This is where output devices come in.

The Video Display

The most common output device is the *video display terminal* (VDT), also called the *video monitor* or the *cathode-ray tube* (CRT). Video displays are little more than television sets without the ability to tune in channels. They are not an essential purchase, since most home computers let you use a color or black-and-white television set as a video display. The computer is hooked up to the TV through a special device called an *RF modulator*, which converts the computer's output to a TV chan-

nel so you can tune it in just like the late movie. An RF modulator may be built into the computer, or it may come in a small box that attaches to the TV set. RF modulators are also used to hook up home video game systems to TV sets.

Since a high-quality monitor can cost more than a computer, you should consider using your TV set for video display. There are some drawbacks, though. Besides occasional disagreements over whether the television will be used as a TV or a VDT, a standard television set doesn't provide as good a picture as does a video monitor designed especially for use with computers. This is not a problem for occasional use, but for tasks that require long periods of

reading the screen (like word processing), you may need the sharper images produced by a video monitor.

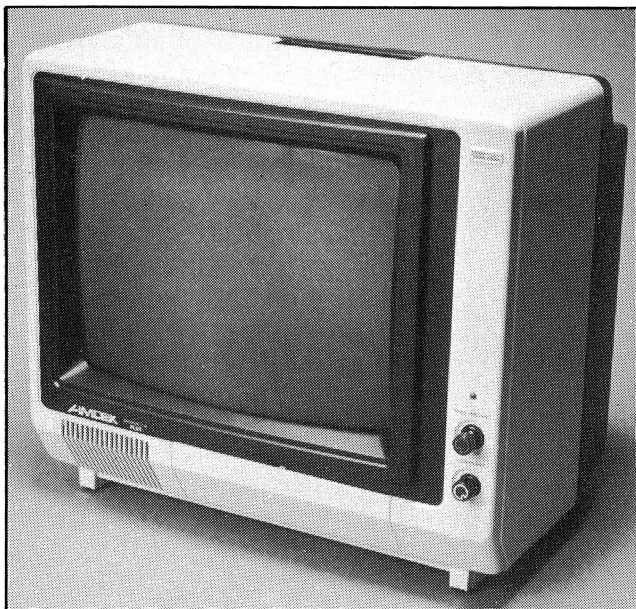
If your computer is capable of producing a color display, you can use either a color or a black-and-white TV or monitor. Although color is valuable for games, entertainment, and many educational programs, it isn't a necessity for making a computer useful. In fact, many of the more expensive small computers designed for professional use aren't capable of producing color. For long periods of use, a black-and-white, green-on-black, or amber-on-black screen seems to reduce eyestrain.

Printers

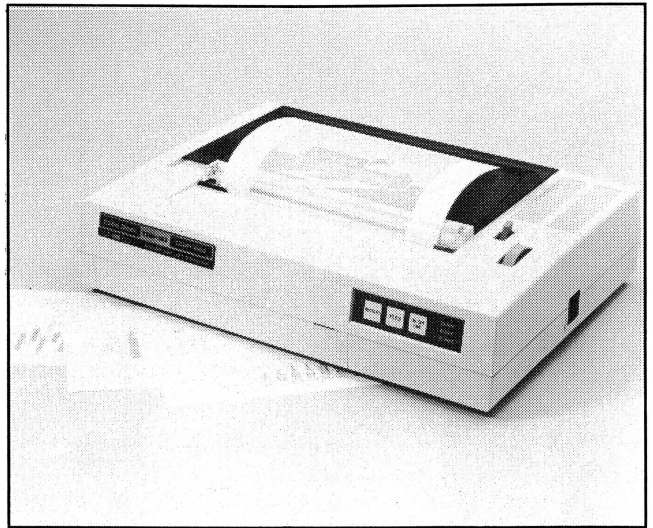
After a video display, the most popular output device is a printer, which is, in effect, a type-writer controlled by your computer. It won't take you long to realize that a printer is almost a necessity. There are many varieties of printers and many price ranges. Printers are discussed in detail in Chapter 4, "Peripherals."

Other Output Devices

Although video displays and printers are the most common output devices, there are a number of other devices that your computer can send data to.



A video monitor is specifically designed to receive computer signals and produces a sharper image than a TV.



A variety of printers is available for printing graphics as well as letters, term papers, and reports.

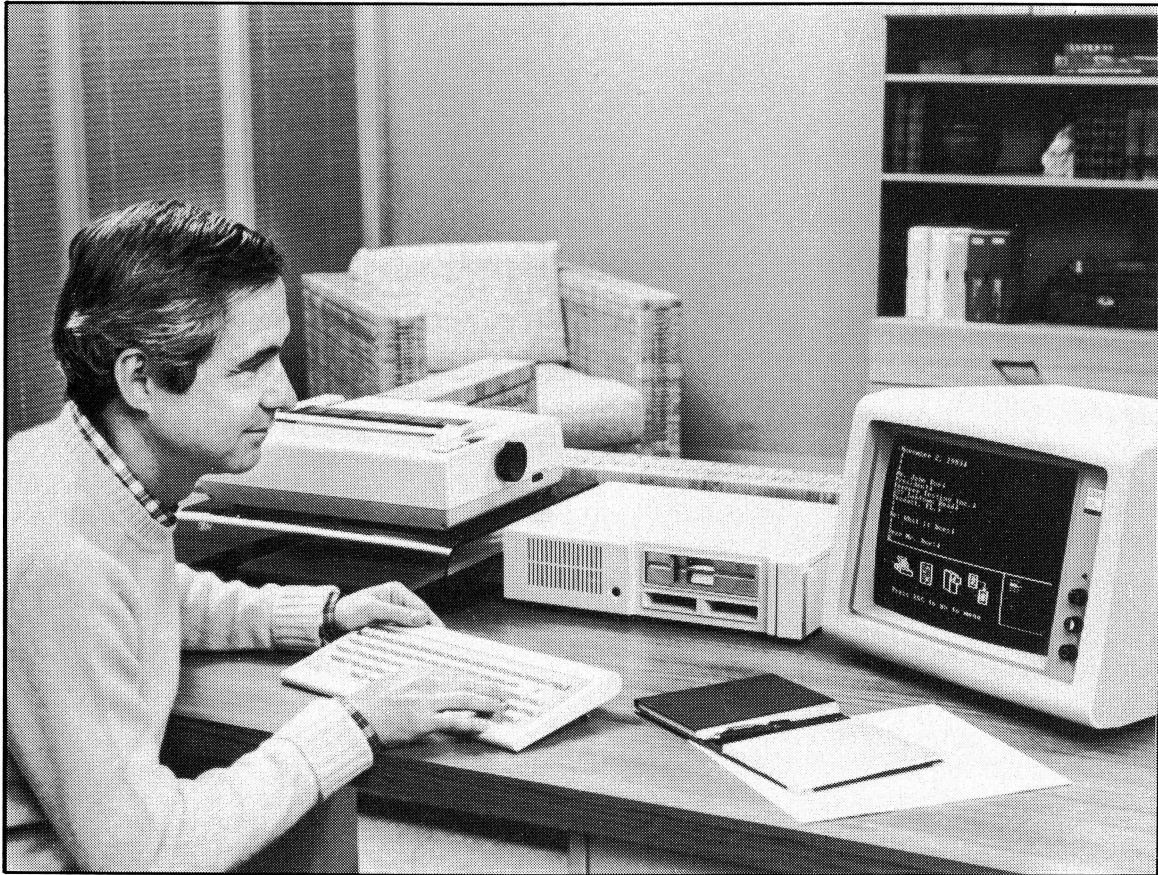
Most home computers have a built-in speaker. Although some can do little more than beep, others can be programmed to play sophisticated music with a built-in tone generation system. In addition, most home computers can be connected to a stereo system and play or record computer music through the system's speakers.

Some computers can even talk to you. *Voice synthesis* is becoming an important aspect of computer use. There are now talking computers in cars and appliances and at checkout counters in stores. Although getting a computer to talk isn't as difficult as getting one to listen (as with the voice recognition discussed earlier), it's still complicated because human speech is composed of many tones. There is software available that can program some computers to speak, but the sound is usually a little tinny.

INPUT/OUTPUT DEVICES

While it's convenient to divide computer hardware into input and output categories, there are some devices that do both. Floppy disk drives, cassette tape recorders, and modems all fit into this category, because they can feed information into the computer as well as take information out. Another input/output device is a *terminal*, which is essentially a keyboard and video display connected to a mainframe computer. These devices and many more are discussed in detail in Chapter 4, "Peripherals."

SOFTWARE: THE KEY TO SUCCESSFUL COMPUTING



We've already talked about computer hardware—equipment like the keyboard, the video display screen, and the complex electronic circuitry concealed under the computer's plastic cover. However, there is more to a computer than that. A computer also needs software—the electrical instructions called programs that tell a computer what to do. Without software, any computer is nothing but a combination of wires, plastic, and silicon.

One way to think about software is to consider a recipe for baking a cake. The recipe is a specific list of instructions that tell you how to bake a cake. In a similar but much more detailed way, software tells your computer how to perform a task. That task can be playing an adventure game, figuring out your taxes, printing form letters and mailing labels, or balancing corporate accounts. In order for the computer to use it, software must be placed into the computer's memory, in a process called *loading*, from some sort of software medium such as a cartridge, a cassette tape, or a disk. We'll talk more about software media later in this chapter.

Not too long ago, most software programs were written by the persons who planned to use them. Now most home computer users rely on prepackaged software, which is written by teams of experienced programmers and sold on cartridges, tapes, or disks. This means that you can use a computer without ever writing a program yourself.

There are tens of thousands of computer software packages available, which serve many different functions for computer users. In this chapter we will talk about software packages you can buy to use with your computer, as well as about the software that comes built into your computer.

LANGUAGES THE COMPUTER UNDERSTANDS

Although you don't have to know how to program in order to use a home computer, you still must know how to communicate with it. Even if all you want to do is use prewritten programs, you need to know how to give some simple instructions to the computer. Today, giving instructions to a computer is much easier than you might think. You don't

have to learn a complicated set of mysterious codes. All you have to do is learn a few English words that mean something to your computer. No, your computer doesn't know English, but it does know an easy-to-use, easy-to-remember language of its own.

Before we go on to software itself, we'll take a brief look at the way software programs are written and the languages that are used to give instructions to a computer.

Machine Language

Any human language consists of a collection of words placed in a logical order to make them understandable to other people. A *computer language* is a set of words or codes placed in a logical order to make them understandable to a computer. Remember that the microprocessor can only understand instructions given to it in binary numbers—1s and 0s. To the microprocessor, these 1s and 0s mean "voltage on" or "voltage off." Combinations of 1s and 0s are strung together to make each "word." These combinations of numbers tell the computer what to do, from a simple task like adding two numbers to controlling the pitch of the space shuttle as it circles the earth.

In the early days of computing, the only way you could communicate with the machine was to give it instructions in a series of 1s and 0s. This binary system is called *machine language* because it is actually the only language a computer directly understands. To see how complicated this method of programming is, look at a simple program to add two numbers. In machine language, it might look like this:

10110110	(GET A NUMBER FROM MEMORY.)
01101101	(GET ANOTHER NUMBER FROM MEMORY.)
11110101	(ADD THE TWO NUMBERS TOGETHER.)
00110110	(PLACE THE TOTAL INTO MEMORY.)

As you can see, this kind of programming takes a long time to learn and to use. And there is also a great chance of making errors. All it takes is just one misplaced 1 or 0 and the program either won't work or won't give the right answer.

Assembly Language

Many people believed there had to be a better way than machine language to instruct computers. This led to the development of *assembly language*, in which a couple of letters take the place of each long string of 1s and 0s used in machine language. An assembly language program to add two numbers might look something like this:

```
LD B,1      (LOAD A NUMBER FROM
             MEMORY.)
LD A,100    (LOAD ANOTHER NUMBER
             FROM MEMORY.)
ADD         (ADD THE TWO NUMBERS
             TOGETHER.)
LD C,00F    (PLACE THE TOTAL IN A NEW
             MEMORY LOCATION.)
```

Although assembly language is an improvement over machine language, the instruction process is still long and subject to errors. Assembly language also requires another program (called an *assembler*) to act as an interpreter, to translate assembly language into the 1s and 0s the machine understands.

High-Level Languages

The next step in the evolution of programming languages was the development of high-level languages. These are nearly like English, in that they give instructions to the computer using common English words like WRITE, PRINT, LOAD, SAVE, and CLEAR. You are probably familiar with the names of some of these high-level languages, such as COBOL, FORTRAN, Pascal, and BASIC.

COBOL (Common Business-Oriented Language) and FORTRAN (FORmula TRANslation) were the first widely used high-level languages. COBOL is primarily used in business, and FORTRAN is used mostly by scientists and engineers. Pascal, named for a seventeenth-century French mathematician, is rapidly becoming a standard programming language because it is highly structured and demands disciplined programming habits. In fact, Pascal is often referred to as the Latin of computer languages.

These high-level languages made programming much simpler. Instead of using all the individual

statements needed in machine language and assembly language, a high-level language could create a program to add two numbers by using only one statement:

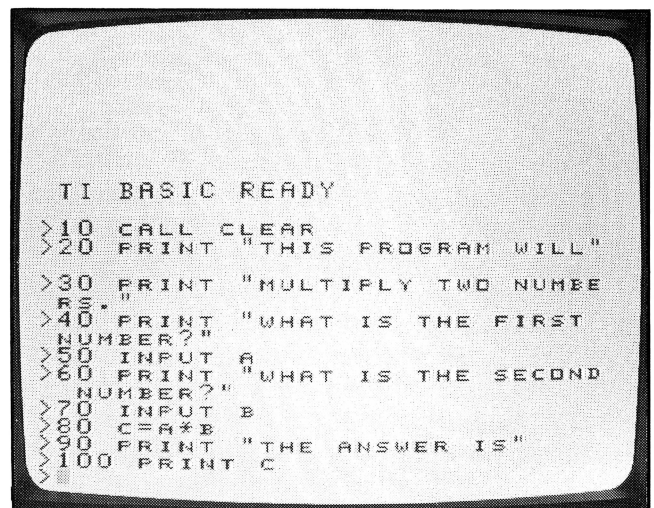
TOTAL = A + B

You can learn to program in these high-level languages because versions of them are available for many microcomputers. But if you want to program, there's a simpler way, and that is with BASIC, the language built into and understood by most home computer systems.

The BASIC Language

BASIC is the most widely used programming language for microcomputers. Its name is an acronym for Beginner's All-purpose Symbolic Instruction Code. BASIC was developed in 1965 to provide a simple way to program. Because it is so easy to learn and use, BASIC rapidly caught on. Its use became even more widespread as more people started using microcomputers.

Many programs for home computers are written in some form of BASIC. Almost all home computers come with the ability to understand BASIC built into ROM. Different manufacturers use slightly different versions of BASIC. The different versions of BASIC are rather like the different dialects of English. Once you learn one version of BASIC, it is easy to learn another version (if you ever need to).



BASIC is easy to learn because it uses ordinary English words to give instructions to the computer.

Programming, particularly with BASIC, isn't only for computer experts. Anyone can learn to write a simple BASIC program in a short time. School children all over the country are learning to do it. While you may never want to go beyond a simple level of BASIC programming, you'll be surprised at what you can do with it. A brief introduction to BASIC is given in Chapter 6.

Writing a computer program takes some time and care. Even a short program requires breaking up a task into simple steps, and all programs must be free of errors in order to work. If you misplace just one space or character in a program, chances are that it won't run at all or that it will stop—or *crash*—in the middle of running. In either case, you would have to find the error (*debug* the program) so the computer can understand what you want it to do.

Some day computers may be able to understand ordinary English. But until then, there are many ready-to-use programs that will do what you want without your having to learn programming. This is why prewritten programs have become so popular. You don't have to know any programming to use them. All you have to do is use the keyboard to enter the information you want processed. These programs are sometimes called *applications programs* because they've been written to handle a specific application or use. We will discuss some of these applications programs later in this chapter.

THE OPERATING SYSTEM: A GO-BETWEEN

Remember that there are two kinds of software: the kind built into your computer and the kind you buy to use with your computer. Perhaps the most important piece of software is the *operating system*, which comes built into the computer.

The operating system functions rather like a traffic cop between the software programs you buy and your computer. Although the program tells the computer what to do to perform a task (like balancing your checkbook), the operating system acts as a go-between to keep everything running smoothly. The operating system tells the program when to stop, when



Software programs come in the form of floppy disks, cassette tapes, and plug-in cartridges.

to go, and what direction to go in. The operating system works with a part of the microprocessor to keep the electrical signals going along their paths in an orderly manner. It also makes sure that there is space available in the computer's memory to store results, and it keeps the microprocessor from trying to do more than one thing at a time.

If you're planning to use a floppy disk and disk drive, you will need a special *disk operating system* (DOS) or *disk controller*. This system coordinates the transfer of information between the computer and a disk. A disk operating system may be built into the disk drive. If not, you may need to have one installed in your computer.

All software is written to run with specific operating systems, but generally all you have to do is buy software that's written for your brand and model of computer. As long as the software you buy clearly says that it will operate on your computer—Atari, Apple, or Adam, for instance—you know it's written for your operating system. If a software package isn't clearly marked for the machines it will run on, check with your dealer to see if it will run on your computer.

Some manufacturers make computers that can use more than one operating system. This is so their machines can run a wider variety of software. In addition, some companies offer

add-on operating systems that you can buy on disks and load into your computer's memory.

There are some standard disk operating systems you will hear about on visits to computer stores, so you should be familiar with their names. One is CP/M (Control Program for Microcomputers). CP/M has become a standard operating system for small computers, and there are thousands of software programs that run under it.

CP/M may not be a standard feature of the computer you are considering, because many home computers can't handle it. CP/M requires more memory than some home computers offer, and additional memory significantly raises the cost of a system. While CP/M is a nice option to have, if you don't feel you can afford it now, don't worry. There is plenty of software around for computers that use other operating systems.

There are other standard disk operating systems. One is PC-DOS, the system chosen by IBM for their Personal Computer. PC-DOS is used with some other computers as well. Another standard system is MS-DOS; the MS stands for Microsoft, one of the leading software manufacturers.

UNIX may be the operating system of the future. Developed by Bell Labs, UNIX can support a wide variety of systems and offers the ability to run more than one machine, a "multi-computer environment." Its most important feature is that it enables programs to be transported among a wide variety of computers.

THE MANY SOFTWARE MEDIA

For some time now, most of us have been in contact with software of various kinds, whether or not we have realized it. The old familiar *punch card* we were instructed not to bend, fold, staple, or mutilate is a form of software. Most of us have used these punch cards to register for courses in school, to respond to public opinion surveys, and to indicate a number of dependents for tax purposes. The holes in punch cards are machine-readable codes for processing data by computer. Many of us still receive paychecks, tax refunds, or social security checks in a punch

card format. As keypunch machines are being replaced with interactive terminals with typewriter-style keyboards, these former harbingers of the computer revolution are being phased out.

A second form of computer software with which we are becoming increasingly familiar is the *Universal Product Code (UPC)*, the pattern of black bars that appears on everything from canned peas to cereal boxes to magazine and book covers. At the checkout counter, these bars are read by a beam of light, telling the store's computer what item is being checked out. The computer instantly identifies the product, tells the cash register the price, and subtracts the item from its memory, giving the store manager an up-to-the-minute record of what is selling and what needs to be ordered. A central computer, which can be hundreds of miles away from the store you are shopping in, is interconnected with all stores in a chain through telephone lines.

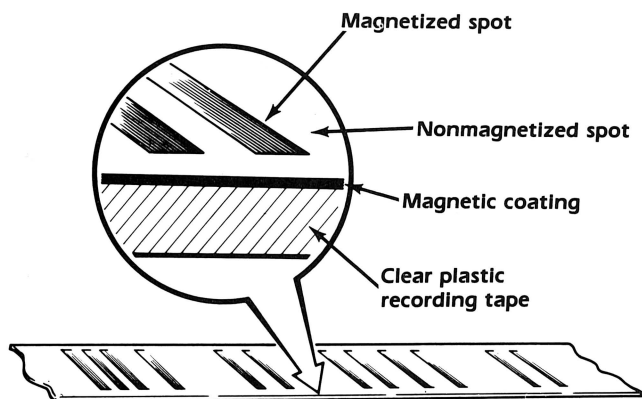
A third kind of computer-readable medium is *magnetic*. The audiotapes used with tape recorders and the videotapes on which most television shows are recorded are magnetic media. The dark strip across the back of most credit cards is a strip of magnetic recording tape that tells a computer about your account.

Most software programs for home computers are recorded on magnetic media, either cassette recording tapes or floppy disks. Both of these forms of software require hardware, a mechanical means of feeding the software's information into the computer.

Cassette Tapes

Recording tape has been the most common form of data storage for computers, not only for microcomputers, but for mainframes used by businesses. You may have seen the large round plastic tape storage cases that contain all kinds of records and data in your own company's offices. Most households today have cassette tape recorders, and many of these standard cassette recorders can be used to store information generated by a home computer.

Cassette tapes are coated with an extremely thin layer of magnetic material. The data—be it



Recording tape is plastic tape with a magnetic coating. Magnetized spots are read as 1s, nonmagnetized spots as 0s.

music or a program for your computer—is recorded in the form of varying voltages. When asked to play back, the circuitry in the recorder takes these voltages and converts them back into music or computer data, whichever was recorded on the tape.

If you listen to a cassette tape that contains a computer program, you'll hear a confusing jumble of tones. Because the program is stored in magnetized regions on the tape as a series of voltages, it produces audio tones when the tape is played back. Because the computer understands only 1s and 0s, the program is stored on cassette tape using two different tones: one tone for the 1s and another tone for the 0s.

An advantage to storing computer programs on cassette tapes is cost. Cassette software is generally less expensive than software on cartridges or disks. There's also a good chance you already have a cassette tape recorder that you can plug right into a home computer. Check carefully, though; some computers require special cassette recorders, made by the same company that made the computer.

The main disadvantage to using cassette tapes for program storage is the speed at which they store and play programs, which is quite slow. It can take more than five minutes to load a program from tape into the computer's memory for use, a waiting time that can seem endless if you use your computer often.

Tape has other disadvantages, too. Exposure to a magnet or to sunlight can destroy the data

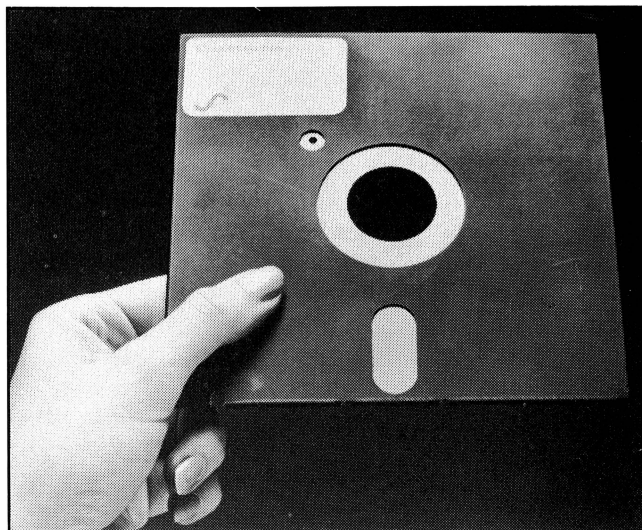
stored on tape. When using a long tape, you may have to spend a frustrating amount of time looking for an individual program. In addition, much of the popular software is available only on floppy disks.

Floppy Disks

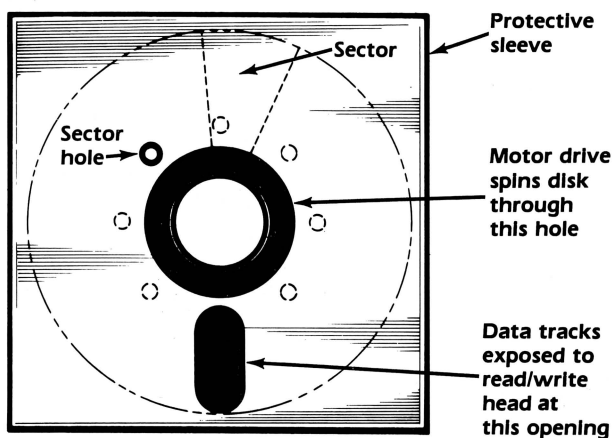
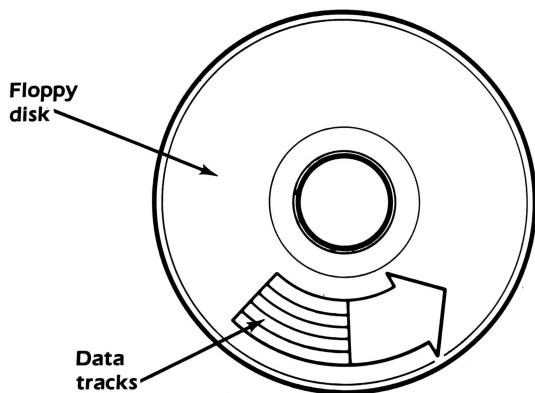
The more we hear about home computers, the more we hear about *floppy disks*, also called *diskettes*. The floppy disk is another magnetic medium. It's a circular disk of light plastic, coated with magnetic material like that used on cassette recording tape. Information is stored in the same 1s and 0s as with tape, but in a series of concentric rings around the surface of the disk rather than in a long string as on a tape. The disk has some similarities to a phonograph record; you may find it easy to think of a floppy disk in this manner.

To use floppy disks with a home computer you must have a disk drive, which is a rather expensive piece of hardware that plugs into your computer. The drive contains a motor that spins the disk at high speed and a head that takes information off the disk and feeds it to your computer, something like the needle of a phonograph. The disk drive can also store new information on a floppy disk when you or the program tells the computer to do so.

Each collection of data on a disk is called a *file* because, like a file drawer, a floppy disk holds each set of information in a magnetic "drawer"



A floppy disk looks something like a 45-rpm record, but it's never removed from its protective sleeve.



On a disk, data is stored in sectors, in tracks like a record's grooves. The disk drive spins the disk and reads the information through holes in the protective sleeve.

under a *file name*. When you want to use this data, the disk drive searches for the name of the particular file "folder" you want. When it finds the file, the computer presents you the information on an output device (like a video display or a printer).

A floppy disk is rather fragile, so it comes in its own plastic sleeve, or envelope, which is never to be removed. Holes punched in the sleeve allow the computer to get the information off the disk with the *read/write head*, which is similar to the record/play head used on cassette recorders. Like tapes, floppy disks can be damaged by exposure to a strong magnet or to direct sunlight.

Floppy disks come in 8-inch, 5 $\frac{1}{4}$ -inch, and 3 $\frac{1}{2}$ -inch sizes. The 5 $\frac{1}{4}$ -inch disk, which is the most common size for home computers, is often called a *minifloppy* disk. The 3 $\frac{1}{2}$ -inch

disk, sometimes called a *microfloppy* disk, is a recent development and is available for only a few systems. Diskettes are called *floppy* because they flop over if held by the edge. This distinguishes them from the *hard disks* used primarily in business. Hard disks have a more solid base, normally of aluminum, on which the magnetic material is coated.

Floppy disks are more expensive to use with a home computer than cassette tapes, but they also have some advantages. They are faster to use, because the read/write head can go right to a particular point of the disk and look only in that sector to find the information requested. Because they are so much more efficient, floppy disks have become the standard for commercial software. Some of the best software is available only on floppy disks.

Information stored on a floppy disk isn't recorded in a series of tones as on a cassette tape. Instead, the data are stored in areas that have either a magnetic charge (1) or no charge (0). Because the disk drive operates so quickly, there is no way the computer could distinguish between tones like those used on cassette tapes. Chapter 4, "Peripherals," gives more details on how a disk drive works.

Plug-in Cartridges

Some home computer software is available in the form of *plug-in cartridges*, or *modules*. The most familiar examples are the plug-in cartridges sold for home video game systems. To use one, all you do is place the cartridge into a slot provided and run the program. Not all home computers, however, can use plug-in cartridges. These cartridges are not magnetic. Cartridges contain miniature ROM chips on which the software is permanently stored. This is the same kind of memory chip that stores the computer's internal operating instructions.

The big advantages of plug-in cartridges are convenience and speed. The programs are ready for your computer to use as soon as you plug them in; there is no delay in loading the program. The program can't be erased without physically destroying the chips in the cartridge. This is a distinct advantage over both tape and disk, which can be damaged or accidentally erased. If you want fast, foolproof operation with a computer, it's worth considering a

model that accepts plug-in cartridges as well as tapes and disks. Although at present there isn't as much software available on cartridges as on cassettes and disks, this may change as the cartridge's many advantages become more widely recognized.

WHAT KINDS OF SOFTWARE ARE AVAILABLE?

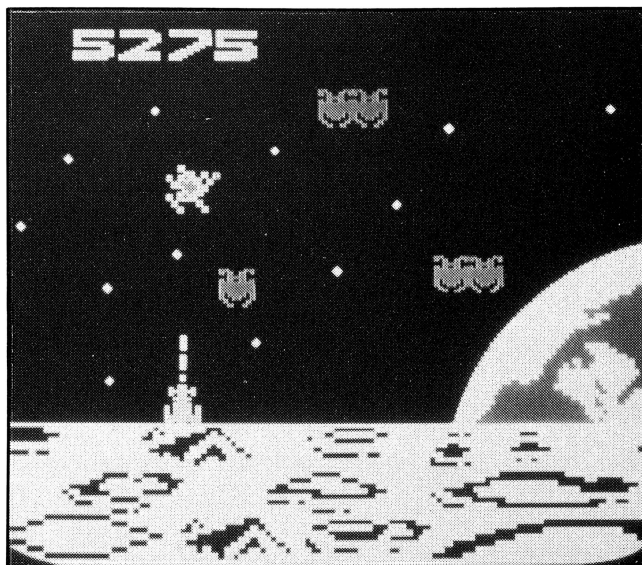
No matter how powerful and expensive a computer you buy and no matter how many accessories you connect to it, without software your pride and joy is like a television set tuned to a blank channel—useless. But how do you begin to choose software tapes, disks, or cartridges for your computer?

Listing all the software available for home computers would take a whole thick book, and because new software is being introduced every month, it would be difficult if not impossible to keep such a listing up to date. One of the best ways to learn about new software is to subscribe to one or more of the many computer magazines, where the advertisements are often as interesting as the articles. Browse through any issue, and you'll see ads for all sorts of software, some of it new and some that's been around for a while. Because of this veritable blizzard of software, most magazines have a new product section that lists newly released software. The Bibliography in this book lists some of the best computer magazines. Keep these in mind as you search for the software you want.

Although it's almost impossible to list all the software available, there are several general categories that are worth considering—games, household problem-solving, education, and business are the most important.

Game Software

One of the biggest and most popular categories of home computer software is games. In fact, chances are that you might be drawn to buying a home computer because you've seen a flashy game demonstration in a local department store or computer store. Computer games can be loosely divided into two types: those that require fast thinking and reflexes and those that are more intellectually



Many computer games combine fast arcade-style action with exciting and colorful graphic displays.

oriented. Games are becoming more and more sophisticated, and many combine fast arcade-style action and the intelligent thinking required of adventure games.

The fast-action games are often based on games that have become popular in arcades. In many cases, the computer games are as good as what you can find in your local arcade—and you don't have to put in a quarter every time you want to play. By the way, arcade games are actually small computers dedicated to the purpose of game-playing. They have a built-in microprocessor, and the actual game program is stored in ROM (read-only memory) chips.

Don't be turned off by the term "intellectually oriented" games. These computer games are as much fun as many fast-action arcade-type games, and at the same time, they make you do some careful thinking. The most common example of these games is *adventures*. In an adventure game, you're given a mystery or puzzle to solve, such as finding gold in a maze. Along the way, you may run into roadblocks, monsters, and other obstacles. Your job is to figure out how to overcome the obstacles. Adventures were the first real computer games, developed by bored computer programmers to liven up their leisure hours. The first adventures were designed for use on large computer systems and were text only—no fancy pictures. Many of today's adventure games use the colorful graphics capabilities of

home computers to their full extent, drawing very detailed pictures.

Most games for home computers are fairly expensive. Because there are so many, it's wise to try them out before buying. If you want suggestions on what games to buy, ask people who own home computers; they tend to accumulate quite a collection of games, so they are a good source of advice.

Software for the Household

Software for household problem-solving is one of the fastest-growing areas for personal computers. There's a wide variety of such software available, with the list growing every day. Next to computer games, the most popular software for home use is designed to help you keep track of your finances and possessions. Today's home finance software will do a lot more than just help you balance your checkbook; it can keep a running total of income and expenditures, plan your budget, and help you with investment decisions. There are tax programs available that will keep records and figure your taxes—and even fill out the tax form, when used with a printer. The more you think about it, the more you'll realize that there are all sorts of uses for a personal computer around your home. Software is available to plan menus, keep track of energy use, and tell you how long it will take to pay back your investment in extra insulation. Programs called *database managers* are also useful around the home, because they help you keep lists of your belongings for insurance purposes. If you're involved with civic groups, you can keep names and addresses in mailing lists. And when used with word processors—special software that lets you write letters and reports—your mailing list can be used to automatically send form letters to members of your group.

Educational Software

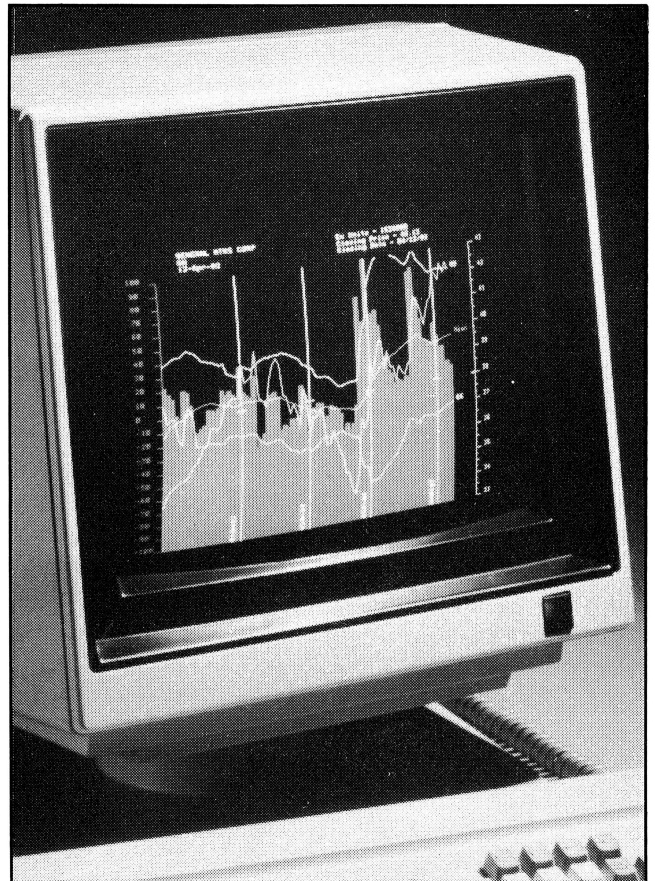
If you have children, a home computer can be a smart investment. More and more companies are using the two-way communication of computers to develop software designed to teach children math, reading, and a variety of related subjects. If you want to give your preschooler a jump on the other kids, you can

buy a program that will teach the basics of math and the alphabet. And programs are available that complement the teacher's efforts as your youngsters continue to grow. Most of these educational programs use fancy color graphics to emphasize their points.

There are also educational programs available for adults. Want to learn a foreign language? There's software available for that, as well as for a variety of other subjects. The educational software area is one of the fastest-growing today.

Business Software

The vast majority of software developed for computers is designed for business use. That's not too surprising when you stop and think that of the hundreds of thousands of computers in use, most are used in business. Over the past few years, personal computers have become more and more popular in business, gradually replacing the huge



Software can perform a variety of business tasks, including producing graphs that can be printed on paper.

machines that people still think of when they hear the term *computer*. Many managers of both small and large businesses have personal computers on their desks.

Because so many personal computers are used in business, many software companies are concentrating on developing programs for business applications. It's not hard to see why. Business software often sells for several hundred dollars, although many low-cost business programs are available for much less than that.

If you're going to be using your computer mainly for entertainment and home record-keeping, you may not be interested in any of this business software. But if you run a business from your home or have other business-related uses for a computer, you should look into some of this software.

Word processing is one type of business software that many home computer owners find useful. Word processing gives you, essentially, a typewriter with a memory. You can move words, sentences, and paragraphs around and add material right in the middle of something else. Some programs actually check your spelling! Word processing is a great boon for anyone who does a lot of writing. Once you've used word processing, it's hard to go back to using an ordinary typewriter.

Electronic spreadsheet programs, which are helpful for financial analysis and accounting, are now available for even the most inexpensive computers. *Database management*—the popular term for what is essentially a system of electronic file drawers—is also available for most home computer systems.

If any of this sounds interesting to you, you'll find that most computer stores specialize in business software. They'll be able to give you advice. It also pays to ask for advice from other computer owners who have used the software you're interested in.

HOW TO BUY SOFTWARE

Remember that an important factor in deciding what computer to buy is whether the software available for that computer will meet your needs—do what you are buying a computer to

do. There is so much software available today—in so many surprising applications and subjects—that even before going to look at computers, you would be well-advised to check software catalogs and the shelves of computer stores to see what is available for which machines.

Once you buy a computer, choosing software can present as many difficult decisions as buying the computer. There are thousands of programs available, only a portion of which will run on your particular computer. Determining whether a software package will run on a particular machine is easy, because software packages are marked to tell you which computers they work on. The package should also tell you how much memory your computer needs to use the software and, sometimes, what microprocessor it works with. But all that really matters is the brand and model name and the memory requirement.

As you start shopping for software, you may well be surprised at some of the prices. New computer users frequently are; they wonder why software is so expensive. Why for instance does a software package cost \$30, \$50, or even \$100? More complicated business software can cost as much as \$500 or more. There are several reasons for the cost. Unlike a phonograph record, which can be recorded in a few days, a computer program can take hundreds, even thousands of hours to write. Getting software from an idea to a package on a dealer's shelf is a long, complicated process. In general, the more expensive a program is, the more time and effort it took to create it. The price of software can be high, but what you're buying is not just the physical product. You are buying the expert knowledge and time of the programmers, and, of course, the convenience of being able to simply plug the software in and use it.

A Library of Quality Software

Starting a library of quality software may well take more time than it did to decide which computer to buy. It's not always easy to determine if a piece of software is a quality product. Except for widely known programs, there is no sure way to decide whether the program you want to buy will perform as claimed. The best advice, unfortunately, is "let



Most software packages are labeled to tell you what computer they can be used on and how much memory is required.

the buyer beware." Most software is not returnable once it has been opened.

If you are considering mail-order software, the best bet is to stick with software packages offered by the large software companies or by your computer's manufacturer. These large software companies and computer manufacturers have their reputations at stake. Word of mouth is also a good indicator of what software is reliable. Talk with members of computer clubs. Most have people who are well acquainted with all sorts of software, and they are usually more than happy to share their opinions about what software may be useful and what you should stay away from.

When you find a software package that interests you, you'll have to be pretty sure it will do what you want it to do. Although most manufacturers will replace a defective cartridge, tape, or disk, you probably won't be able to return a software program just because you don't like it. In many cases, a computer store will have a demonstration copy of the software and the instruction manual that goes with it. If at all possible have the software demonstrated for you. Also examine the manual closely; it may be poorly written or too technical.

Sometimes, a software package will contain printed information about the manufacturer's

policy regarding replacement copies in case the original is damaged or wears out. To take advantage of this, you must send in the registration card included with the software package. If a software package doesn't mention replacement, ask the dealer about the company's policy before you buy.

Developing a good working relationship with your local computer store is a good idea. The manager and salespeople usually know a great deal about software and hardware, and they are usually willing to share their knowledge. Although any individual store can carry only a small fraction of the programs available, a dealer will usually let you try out the software before you buy. This is the best way to make sure you'll be happy with it.

Software for Free

An alternative to buying software is *freeware* or *public domain software*. These programs are available either for free or for a small donation to the developer. Many programs are available from clubs or from telephone-access computer bulletin boards.

Many of these free programs are available as printed multipage listings of BASIC code which you can type into your computer and then save on tape or disk. Because every computer manufacturer uses a slightly different form of BASIC, you should make sure the program is written for your computer. Otherwise you may have to make some changes in the program as printed so your computer will understand it. Besides making sure that a program will run on your home computer, you will have to spend the time typing the program into your computer. But considering the cost of packaged software, free printed programs might be worth the work to you. Even if you cannot find exactly what you want, you can make changes in this software so it will suit you.

Computer books and magazines are often full of these free programs. Browse through the computer books and periodicals in public or college libraries. Many computer clubs have a program exchange, where you are likely to find a lot of free software. Some of this may be available on floppy disk or cassette tape, which you can copy, for just the cost of the disk or tape. Make sure, though, that this software is

in the public domain or was developed by the person offering it. As with phonograph records or videocassette tapes of movies, it is illegal to make copies of copyrighted computer software without payment of royalties to the copyright owner.

Piracy and Copy Protection

One of the stickiest problems of the growing computer industry is piracy, the illegal copying and resale of software. Although it might seem attractive to pick up a copy of the latest computer game from a friend for \$5 instead of the \$35 the manufacturer may be charging for it, do not do it. Not only is it illegal, but you won't have any guarantee. If the program doesn't work, you won't get any service; there will be no instructions, which are often essential in order to use the software; and the copy may be bad or not work on your computer. Good commercial software may be expensive, but it protects you against all these risks.

The most unfortunate result of software piracy is that it stifles the development of new computer software. A number of software companies have gone out of business over the past few years because of money lost to

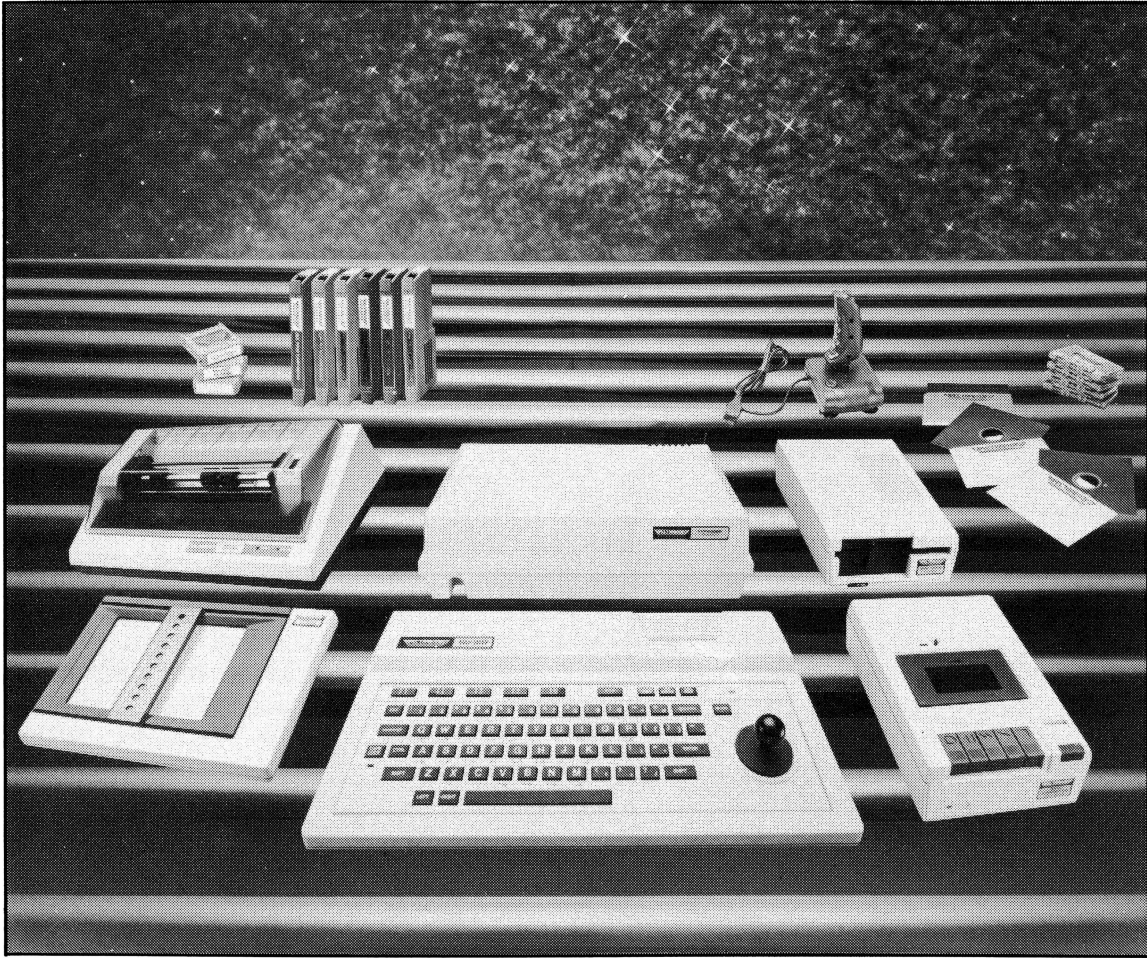
pirated copies of their software. Today, many software companies are fighting back by putting a programming device called *copy protection* in their software. These are sophisticated programming techniques that attempt to prevent illegal copying of a program. These protective codes, however, work more to impede than to prevent unauthorized copying, since crack programmers can break these codes if they are so inclined.

While copy protection protects the manufacturer, it is an inconvenience to the computer user. It has long been a standard operating procedure for computer users to make a backup copy of a program as soon as they buy it, then put the original away in a safe place and use the copy. This way, if something happens to the copy—cassette tapes and floppy disks do get damaged and wear out—the original can be taken out and recopied. Copy protection, however, prevents this. Most companies that protect their software will sell low-cost backup copies when originals wear out, but this is of little help if a program is ruined in the middle of an important project. Find out the manufacturer's policy on backup copies before buying a piece of software, particularly if it is a program that you will be using frequently.

```
210 INPUT AS
220 LET TS=TS+AS
300 REM FIXED EXPENSE CALCULATIONS
310 REM MORTGAGE=$682.83
320 LET A=682.83
330 REM CAR PAYMENT=$188.85
340 LET B=188.85
350 REM SECOND CAR PAYMENT=$124.80
360 LET C=124.80
370 REM CAR INSURANCE=$32.30
380 LET D=32.30
390 REM BEDROOM FURNITURE=$57.50
400 LET E=57.50
500 LET FX=A+B+C+D+E+F+G+H+J+K
600 FOR CL=1 TO 30:PRINT:NEXT CL
610 PRINT "I WILL NEED INFORMATION REGARDING"
620 PRINT "THIS MONTH'S VARIABLE EXPENSES"
630 PRINT:PRINT "GROCERIES COST?"
640 INPUT M
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Many computer books and magazines include printed programs that you can type into your computer and use.

PERIPHERALS: INCREASING YOUR COMPUTER'S POWER



In this chapter, we'll discuss computer peripherals. They are the accessory devices that increase the power and flexibility of a home computer by helping you get information into and out of it as quickly and efficiently as possible. We'll look at the many devices that input information, output information, or handle both input and output. And there's another type of peripheral that adds computing power to the system—extra memory.

Some of the accessories we'll discuss are similar to the ones used with more expensive and powerful business computers. Some peripherals can be expensive; in fact, some of them cost as much as or more than a home computer itself. But the versatility they add is often well worth the price.

CASSETTE TAPE RECORDERS

Only a few years ago, the cassette tape recorder was the standard way to store micro-computer programs. Cassette tapes are readily available and inexpensive, but they also have several disadvantages.

Besides being very slow, cassette recorders cannot move data to and from the computer quickly enough for efficient use. This is a great limitation, because much of the sophisticated software available today relies on speed to work efficiently.

Further, cassette recorders usually aren't automatic. With the exception of the recorders made to work with certain home computer systems, cassette tapes must be manually advanced or reversed to find a particular program or piece of information. You must also physically start and stop the recorder. Finally, cassette recorders are more prone to errors in recording and playing back data than are other data input/output devices.

Cassette recorders have another disadvantage, too. Less and less software is available on cassette tape. In fact, some computer companies no longer sell cassette tape recorders or even provide a place to plug them into the computer. Of computers that still can use tape storage, several require a special tape format, which means that you can't use an ordinary tape recorder with them. Among these are the Coleco Adam system and the Atari computers.

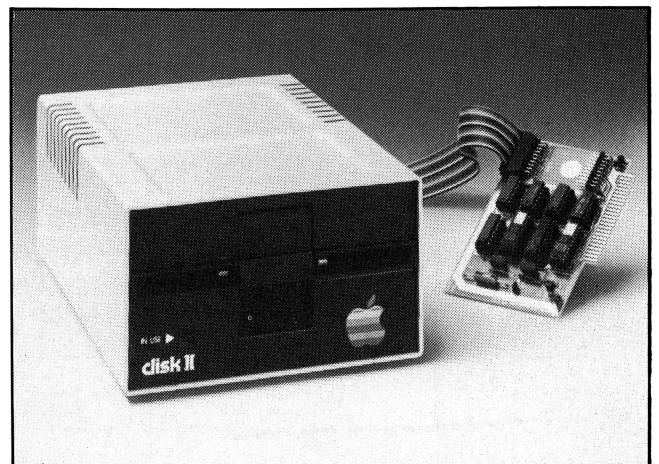
If you do get a computer that can use cassettes and you have a tape recorder, you can probably use it. The only extra equipment you need is a special cord to connect the computer and the recorder. However, check with your dealer first and be sure your home computer will work with the cassette recorder you have.

FLOPPY DISK DRIVES

Floppy disks, which look something like thin 45-rpm records protected by plastic envelopes, have become the standard for home computer software. They are now the most common way of entering and storing information.

Using them requires a special device for your home computer, the floppy disk drive. This is an input/output device that usually plugs into your computer; in a few systems, a disk drive comes built into the main computer console. A disk drive contains two important components: a motor that spins the disk at high speed and a read/write head that takes the magnetic information off the disk and feeds it to the computer. The head also records new information on the disk. While the head on a tape recorder remains stationary as the tape passes over it, the head on a disk drive moves back and forth across an opening in the disk's protective sleeve. The disk spins quickly below it, which accounts for the disk drive's speed in reading and recording data.

Information is stored on the disk in binary form. To coordinate the transfer of information between the computer and disk drive, you



A disk drive is by far the fastest way to get programs and information into and out of your computer.

need a *disk operating system*, or *disk controller*, the “traffic signal” system that was described in Chapter 3. A disk operating system either is built into the disk drive or must be added to your computer’s internal memory. Be sure to check this with your dealer when looking at disk drives.

Working with a Disk Drive

The biggest advantage to using a disk drive is that much of the best software is available only on floppy disks. This is because it’s possible to pack far more information onto a disk than onto a cassette tape, and in turn, this information is easier for a computer to use.

The second primary benefit of a disk drive is speed. Because it is a random-access device, even the longest computer program takes only seconds to load into a computer from a floppy disk. This *random-access* capability means that when you tell the computer to find a program on a disk, the read/write head goes directly to it without having to look through all the information that comes before it. The disk can do this because it has a directory—a magnetically coded index to the location of every program or file it contains, something like a book’s table of contents. The computer can find the program and load it into memory in seconds, because the floppy disk is spinning at hundreds of revolutions per minute.

To better understand how the computer finds information on a disk, compare it to finding a particular song on a long-playing record. To find the song you want to listen to, you look at the record label, find the track where the song is, and put the tone arm’s needle down in that area. In a sense, this is an example of random access. You can go straight to the particular tune you want and disregard everything that comes before it. The floppy disk system works in a similar way.

The speed of a floppy disk drive and its random-access capability are important because many programs require the computer to frequently get information from the disk and put information on the disk. This is almost impossible with a cassette.

The only disadvantage to using floppy disks is the cost. Although the disks themselves cost

only \$3 to \$5 each, a disk drive adds \$300 to \$500 to the cost of your home computer system. Floppy disk drives are available for nearly all home computers, but considering their expense, you should carefully weigh your need for one. However, their versatility and the capability they add will probably convince you that despite the price, you’ll need one now or later.

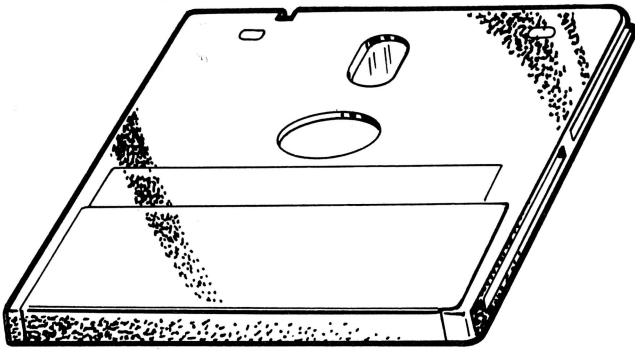
Types of Disk Drives

Currently, the standard disk size for home computers is the 5¼-inch *minifloppy* disk. Most commercial software for home, education, and office use is made in this size. There are also 8-inch floppy disks and drives, but this size is less common.

Another size disk you may hear about is the *microfloppy* disk. A relatively recent development, these disks range in size from 3 to 3½ inches and hold as much or more data than standard minifloppy disks. Microfloppy disks are generally easier to handle, too, because they are encased in hard plastic covers that offer greater protection. They also require smaller disk drives. So far, there are few standards for microfloppy disks, but this will change over the next few years. Their greatest advantage is the space they save, but the drawback is that there are presently three or four competing sizes. If you choose to use microfloppy disks, your software selection will probably be limited to that offered by your computer manufacturer, but this is likely to change in the near future.

Double-density and double-sided are other special types of disks and drives, which increase the amount of information that can be stored on and retrieved from the disk. *Double-density disks* hold twice the information that the ordinary single-density disks do, because the magnetic areas that contain the information are packed more closely together. Reading this information requires special disk drive circuitry and a read/write head that is more expensive than those used in single-density drives.

The ordinary read/write head reads information from only one side of the disk. Most disks are capable of recording on both sides, but a second read/write head and additional circuitry are needed in order to do so. Disk drives of this type are called *double-sided* because they



Microfloppy disks are encased in hard plastic covers. They hold as much or more data than minifloppy disks.

can read information from both sides of the disk.

Both double-sided disk drives and double-density disk drives effectively double your information storage space. A disk drive that is both double-sided *and* double-density can store four times the data as a regular drive; for this reason they are called *quad-density* drives.

Double-density, double-sided, and quad-density disk drives aren't available for all home computers. Because they have more parts, they're usually more prone to problems. Single-density disks and drives are still the most common for home computers, though perhaps not for long. Although the more sophisticated drives are more expensive, their data capacity is so much greater that they may soon become more popular.

The last type of storage is the use of additional RAM in place of a real disk drive. These are very high-speed units that, in effect, tell a certain portion of the RAM to act electronically like a disk. They enable data to be stored and used instantly. They are cost-efficient, but they have a key drawback—their memory is volatile. Unless you tell the program to move everything back to a standard disk drive when you are done using it, the information disappears when the power is turned off.

Choosing a Disk Drive

When buying a disk drive, your best bet is to stay with the drive made by your computer's manufacturer. In this way, you can be sure the drive is compatible (will work) with your com-

puter. You can, however, buy a drive made for your computer by an independent manufacturer. These drives are usually identical to those offered by computer manufacturers, but they are often available at lower prices. This requires careful checking, though, so drives offered by your computer's manufacturer are a safer bet.

How Much Data? The amount of information a floppy disk holds is measured in K, as is the computer's internal memory. Remember that each K is 1,024 bytes; there are 8 bits—individual areas of magnetic charge or no charge, 1 or 0—in each byte.

Single-density floppy disks do not all hold the same amount of data; this depends on the circuitry in the disk drive. A 5¼-inch single-density floppy disk usually holds between 100K and 175K of data—the equivalent of 50 to 85 double-spaced typewritten pages. This amount doubles for double-density or double-sided disks and quadruples for quad-density disks. Eight-inch disks hold even more, from 500K to more than 1 million K. Microfloppy disks can hold anywhere from 160K to more than 600K, depending on the coding technique used.

What kind of disks—and disk drive—should you buy? It really depends on your needs. Since most commercial software is available on single-density floppy disks, a standard single-density drive is probably all you need now. If the standard for software changes, you may want to change your drive, too, but this is in the future.

How Many Drives? Although you need only one disk drive to run most commercial software, you may want to consider buying a second drive for some applications. For example, a single floppy disk may not have enough room to hold a large mailing list. In addition, many advanced software programs, especially for business use, need to get to information on more than one disk at a time.

Another advantage to a second disk drive is in chores such as copying data from one disk to another, as when you make a backup copy of a new program. A second disk drive makes this work much easier and faster. When you must use only one disk drive to make a copy, the computer has to take part of the information on the disk, store it in RAM, wait for you to

change to a blank disk, take the information from RAM, put it on the blank disk, wait for you to put the original disk back into the drive, and the whole process has to be repeated again. If your original disk is full of data, you may have to switch disks 15 or 20 times. With a second disk drive, you simply insert the original disk in one drive and a blank disk in the other and then tell the computer to copy.

A second disk drive usually costs about \$100 less than the first one, primarily because the second drive doesn't need a controller—the circuit board that controls the transfer of data from disk to computer and back. A disk controller or operating system is built into the first drive, and only one controller is needed, regardless of the number of drives. More than two disk drives can be used with a home computer, but for most owners, two drives are ample.

An Essential Accessory. If you buy a disk drive, a head-cleaning kit is a necessity. This is an inexpensive accessory that cleans residue off the read/write head.

Over time, the magnetic coating on floppy disks tends to wear off, much as it does on ordinary recording tape. This is why it's important to make backup copies of important floppy disks if you can. As disks wear out, this residue builds up on the disk drive's head, making it prone to errors in reading data, which can be a major problem.

A head-cleaning kit costs about \$15 to \$30. It consists of a special floppy disk with an absorbent pad in place of the magnetic surface. You pour a special cleaning solution on the pad and run the disk in the drive. The special disk cleans the accumulated residue off the drive's head. This cleaning also results in longer life for disks.

HARD DISK DRIVES

Many business computers use *hard disks* and drives, which are frequently called Winchester. They are rigid disks made of aluminum and coated with the same magnetic material used on floppy disks. Hard disks are capable of working at much greater speeds and storing vast amounts of data. A hard disk, for instance, can store from 5 to 10 million bytes. That's

well over 2,000 typewritten pages, while the standard floppy's capacity is 50 to 85 pages.

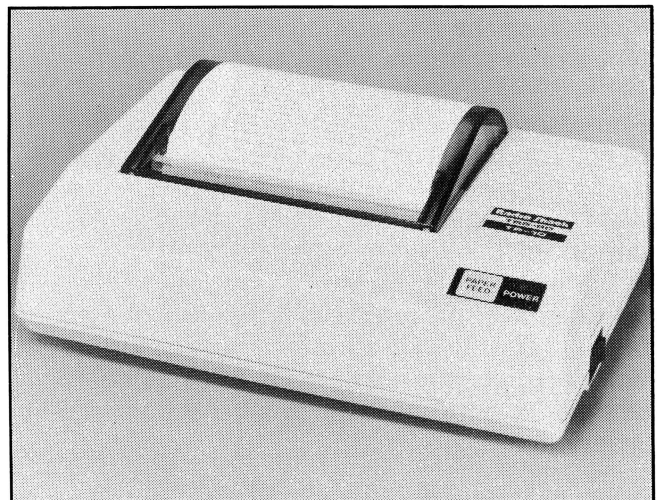
Hard disks are appropriate for serious business applications, where large amounts of data must be available for immediate use. They aren't normally used with home computers, because they are expensive and because few home computer users need such high storage capacity. Hard disk drives cost from \$1,200 to \$3,000, although it is possible that these prices may eventually fall below \$1,000, which would make these units more practical for home computer use.

PRINTERS

As you begin working with a home computer, you may soon realize that you often want to look at the information on something other than the video display screen. This is when you realize the importance of a printer.

If you begin without a printer, you can save information by using a cassette tape or floppy disk. But you still have to load the data back into the computer and read it off the video screen in order to recall what you have written. Ultimately, if you want *hard copy*—a printed document—you need a printer. The printer provides a portable record of the information that anyone can read without having a computer around.

You might consider a printer to be like a one-way typewriter. It prints information the com-



An important peripheral is the printer, which gives you a permanent, portable copy of your information.

puter feeds it, but it has no provision for entering information into the computer, which is the keyboard's job. The printer takes the binary code the computer uses and translates it into letters of the alphabet, numbers, or punctuation marks.

Once you start shopping, you'll find a wide variety of printers available, which range in price from as low as \$150 to \$2,000 or more.

As you might imagine, the quality and features of printers differ considerably. The chief difference among printers has to do with the way the printer forms characters on paper. *Impact printers* use a printhead that strikes a ribbon against the paper. *Nonimpact printers* use special mechanisms that don't contact the paper directly. Once you are familiar with this basic difference, the finer distinctions are easier to understand.

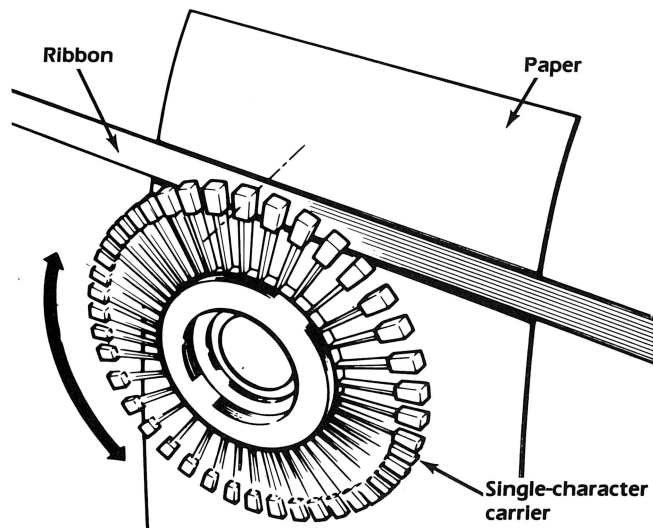
Impact Printers

There are two types of impact printers: letter quality and dot matrix. *Letter-quality* printers produce fully formed characters on paper, much like a regular typewriter. *Dot-matrix* printers form characters from patterns of individual dots that are printed in groups.

Letter-Quality Printers. Impact printers that produce fully formed characters work in the familiar way a typewriter does. A hammer strikes a movable wheel or cylinder covered with embossed characters and forces the characters against a carbon or inked ribbon, which strikes the paper. These printers are called *letter quality* because the characters look as if they were typed on a standard office typewriter.

Even though the finished product looks the same, you won't find many printers that work the same way old-fashioned typewriters do, with a movable arm for each character. The reason for this is speed. Computer printers are designed so the print element moves as little as possible; the shorter the distance it moves, the faster it prints. Fully formed character printers work at speeds ranging from 12 to 55 characters per second, far faster than the standard typewriter.

Many fully formed character printers have replaceable printing units—like the type ball on

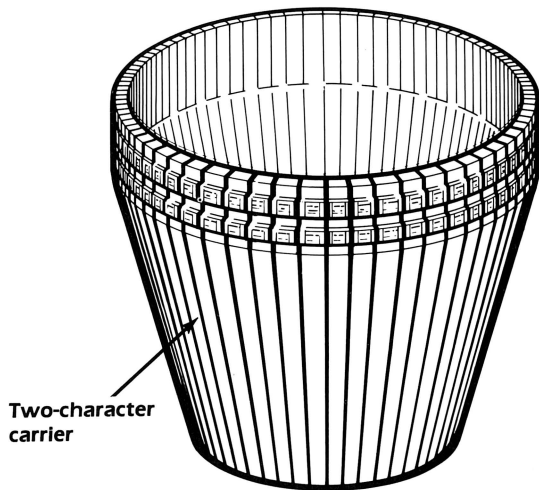


Some printers use a printing element called a daisy wheel, which has embossed characters on the "petals."

office typewriters—that allow you to use various sizes and styles of typefaces. The most common printers use a printing element called a *daisy wheel*, which resembles a flower with the "petals" containing the individual print elements for letters, numbers, and other characters. In operation, the wheel spins at high speed and the character needed is hit by a hammer as the wheel spins by. The wheel and hammer are mounted on an assembly that moves across the paper. All computer printers use print assemblies that move—the days of moving typewriter carriages, which move the paper, are gone.

Daisy wheel printing elements are easy to change. Many people keep several on hand to change typefaces quickly. They are usually made of tough plastic and cost about \$10 to \$15 or more. They do eventually wear out and must be replaced. Metal daisy wheel elements are available, too, but they can't be used with all printers and are much more expensive, running from about \$40 to \$50. Unless you'll be using a daisy wheel in business where the printer must work all day, every day, a plastic daisy wheel is all you need.

Another kind of printing element for fully formed characters is the *thimble*, which looks like a daisy wheel with the spokes bent upward to form a cup. These printing thimbles are made of nylon-reinforced fiberglass and cost about \$15. As with daisy wheels, there is a wide variety of type styles available for thimble elements.



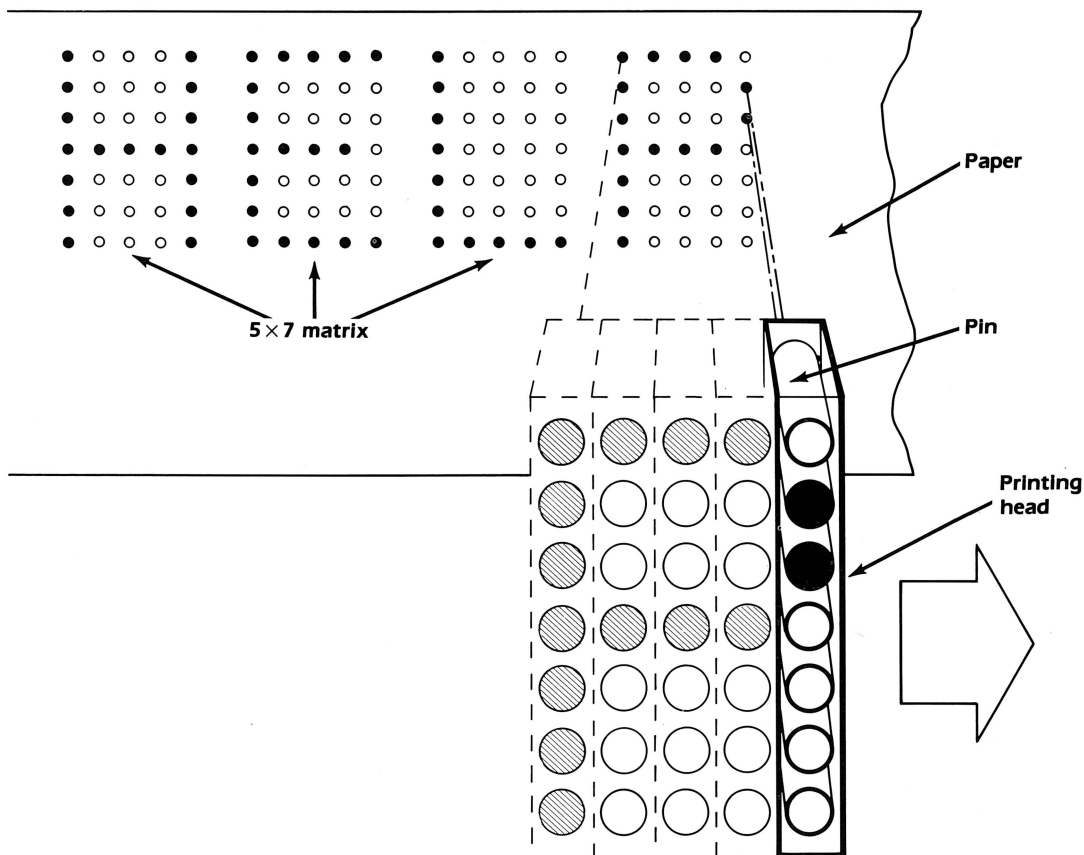
The thimble is a printing element that looks like a daisy wheel with the spokes bent up.

Daisy wheel and thimble printers for home computers vary greatly in price. The least expensive are available for about \$600, and the most expensive cost as much as \$2,500 or

more. But they do offer the highest print quality by far. Whether or not you need one depends on what you'll be doing with your computer and printer. Both are useful, if not essential, for word processing, if your output must have a professional appearance.

By computer industry standards, these daisy wheel and thimble printers are slow. Though 12 to 55 characters per second is lightning quick compared to even the fastest typist, it's slower than the up to 300 characters per second that dot-matrix printers can achieve. But speed is relative. If you'll be printing only a few letters at a time, speed is not a consideration. But if you're running a business and expect your computer to send out invoices and generate long reports, you may need the extra speed of another type of printer.

Dot-Matrix Printers. By far the most popular printers for home computer use are the *dot-matrix* variety, called that because they form characters with patterns of individual dots that



Dot-matrix printers form characters made up of individual dots on the paper. The printing head has a vertical row of pins, which are fired against a ribbon as the head moves across the paper.

impact the paper very rapidly. Most dot-matrix impact printers have a vertical row of needle-like pins, which are individually fired against a ribbon as they move across the paper. Each pin produces a single dot as it strikes the paper, and the patterns form the individual characters.

Because they have fewer moving parts than fully formed character printers, the dot-matrix impact type is less expensive and more reliable, as well as very fast. Although the print quality of the dots usually looks like computer print-out, some dot-matrix printers now use such tightly packed patterns of dots that their type quality is almost as good as that of daisy wheel printers. In fact with some, you have to look very closely to see that it's dot matrix, but these special printers are also more expensive.

Dot-matrix impact printers are faster than fully formed character printers; speeds of 80 to 200 characters per second are common. A good quality dot-matrix printer can be bought for less than \$200—an important consideration.

Nonimpact Printers

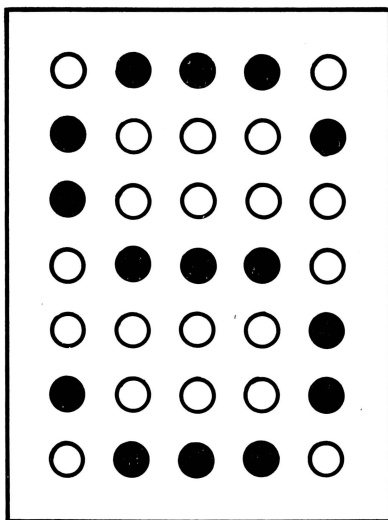
As the name implies, *nonimpact printers* create characters without actually striking a ribbon against the paper. They use various mechanisms to accomplish this—heat, electrical sensitivity, ink jets, and even lasers. Depending on how they work, nonimpact printers can be either inexpensive or extremely expensive.

Generally, they aren't as popular as impact printers.

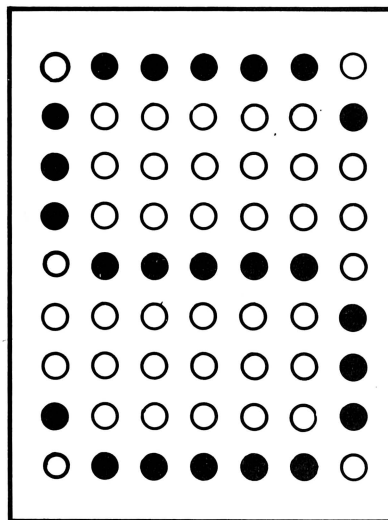
Thermal Dot-Matrix Printers. These printers use a process that scorches dots on heat-sensitive paper, producing letters in a dot-matrix format. They are generally less expensive than impact dot-matrix printers, but this price difference is closing rapidly. Their cost advantage must be weighed against the disadvantages of the special paper, which is difficult to copy, tends to fade with age, and is unsuitable for most business uses. However, for quick copies of a program or a short-term printout of checks, a thermal printer may be suitable.

Other Nonimpact Printers. The *electrographic dot-matrix printer* combines the dot format with a special electrically sensitive paper composed of very thin aluminum foil over black paper. Needle-thin wires in the device's printhead touch the paper, applying an electrical current that makes holes in the aluminum and exposes the black paper underneath. These printers are very quiet and inexpensive, but their special paper is expensive and difficult to store, and the quality of the printed copy isn't good enough for most business applications.

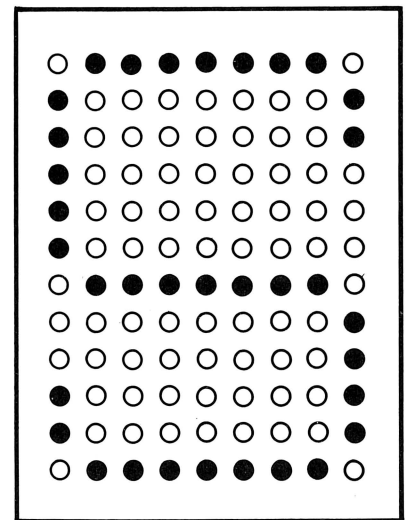
Ink jet printers fire tiny jets of special ink at the paper, forming characters made up of individual dots. The ink is controlled by a magnetic field. These printers are extremely quiet and phenomenally fast; they can print an entire page in about a second. But they are also ex-



5×7



7×9



9×12

Not all dot-matrix printers give you the same print quality. Some printers use more dots that are closer together, producing more readable characters. Common matrix sizes are 5 rows by 7 columns, 7 by 9, and 9 by 12.

tremely expensive, currently about \$10,000. Because their price is expected to drop drastically in the next few years, they may soon be available and affordable for serious business applications.

The laser, a powerful beam of light so popular with science-fiction writers, has become a workhorse in many industries. *Laser printers* scorch images on ordinary paper using a tightly focused laser beam. Now they're as expensive as ink jet printers, but their price, too, will certainly fall in the years ahead.

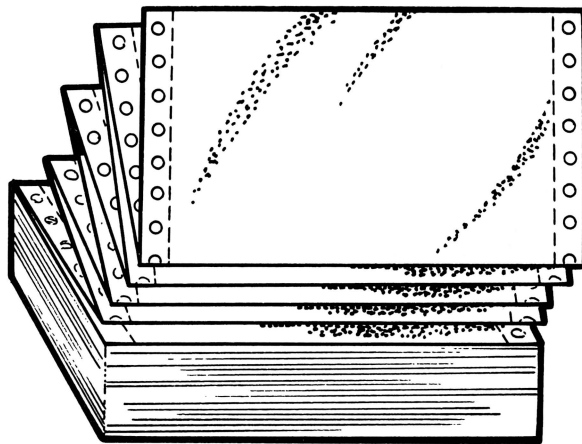
Choosing a Printer

Like buying the computer, choosing a printer should be a careful process. There are many factors to consider, including reliability, print quality, paper cost, and service availability. Here are some of the factors to keep in mind when shopping for a printer.

The Ribbon. All impact printers use ribbons. Because they do, it brings to mind certain questions. Is the ribbon for the printer readily available? How expensive is it? How long will it last? Further, what about changing the ribbon? Is it as simple as popping in a cartridge, or is it a messy, complicated job? Remember, the quality and condition of the ribbon controls the quality and legibility of the printed page. Some companies offer both low-cost reusable nylon ribbons and one-time-use carbon ribbons that produce a crisper image. This gives you a choice of print quality—carbon ribbon when the page has to look good, and reusable nylon ribbon when print quality isn't so important.

The Paper-Feed Mechanism. There are two common methods of feeding paper through a printer. The first, called *friction feed*, works like the roller on a standard typewriter. This method is fine for short letters, but for long multipage documents you'll have to sit in front of the printer and keep feeding paper by hand.

A more common approach for computer printers, especially the more expensive varieties, is *pin feed*. This method uses special continuous sheets of paper with holes along each side that catch on stubby pins encircling a wheel, which pull the paper through the printer. This type of paper is the classic computer printout with which you're already famil-



Fan-fold paper is fed through the printer in a continuous sheet. After printing, it is separated into single pages.

iar. The paper is perforated every 11 inches so it can be separated into letter-size sheets. Most computer paper is also perforated along the edges, so the borders of holes can be removed from the pages.

The *tractor-feed* printer is a variation on the pin feed. Instead of using fixed pins at either side of the roller, tractor feed works with paper-carrying mechanisms that can be moved along metal tracks above the roller, enabling you to vary the width of the paper you are using, from tiny strips to wide pages.

Pin-feed and tractor-feed mechanisms add cost to a printer because they have a number of moving parts. If you need to print business forms or mailing labels, however, a pin-feed or tractor-feed printer is a necessity. They keep labels and forms lined up so that information is printed in the correct place on the paper each time.

The paper used on these printers is called fan-fold, because it's folded like accordion bellows every 11 inches. This paper costs about the same as regular paper on a per-sheet basis, but it has a few disadvantages: top-quality letter paper isn't available and the sheets must be manually separated and the edges torn off.

Printing Speed. A printer's speed is specified in *characters per second* (cps). Letter-quality printers have speeds ranging from 12 to 55 cps; the slowest will take more than two minutes to print a page, while the fastest will print two pages a minute. Dot-matrix printers start at about 55 cps and go up to 300 cps; at that

speed, a whole page is printed in a little over 5 seconds.

You probably don't need such high speed unless you plan to use your computer all day, every day, to print hundreds of bills or mailing labels. If speed is not a major consideration, the extra convenience isn't worth the extra money you'll have to pay.

Characters per Line. Many low-cost printers can print no more than 40 characters per line. This contrasts markedly to the standard typewriter which prints about 80 characters per line. A 40-character line may not be sufficient for word processing and some other business applications; in fact, for most uses, you will find an 80-character line much more practical. There are also printers that can handle up to 132 characters per line, which can be useful for business applications. Since they are not much more expensive than 80-character printers, these wide printers can be a good investment for business use.

Type Styles. There's a large variety of type styles available with letter-quality printers. Changing from one type style to another involves only popping the daisy wheel or thimble in and out.

Dot-matrix printers use software control to generate a variety of type styles. Depending on the model of printer, type styles range from plain block lettering to script, pica or elite, **boldface** or *italic*. These changes can usually be made in the middle of a sentence without changing any equipment. More expensive dot-matrix printers use more dots per character for a crisper, cleaner image; common matrix sizes are 5 rows by 7 columns, 7 by 9, and 9 by 12. To be sure the printer you're considering offers what you need, take a look at a sample print-out before making your purchase. Don't buy a printer until you're sure the print quality suits your needs.

Graphics. Some dot-matrix printers can print charts, graphs, and other graphic images off your video display screen. It's worth getting this capability if it is available, and it's usually relatively inexpensive.

Interfaces. To plug your printer into your computer, you'll need an *interface*, an electrical gadget for transferring data from the computer

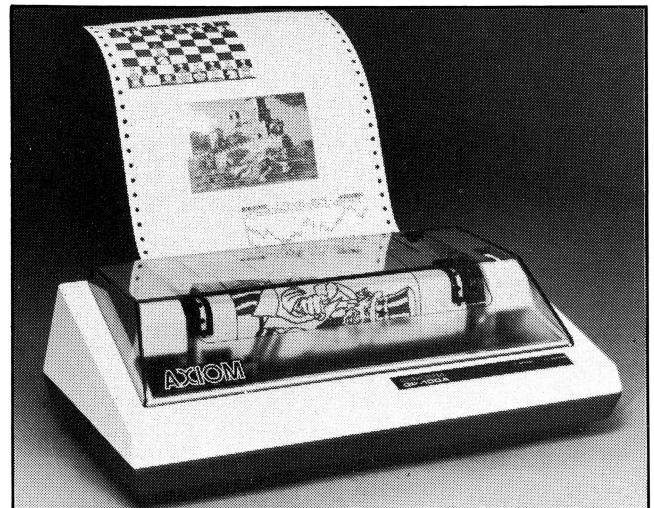
to the printer. Some printers use a *serial* interface; some use a *parallel* interface; some can use either one. We won't go into the technical specifications, but your printer must match your computer. Before buying a printer, talk to the computer dealer to make sure that the printer will work with your computer and to make sure that you get the proper interface.

Other Considerations. Here are some other factors to consider when buying a printer. How noisy is it? Does it vibrate a lot? A noisy printer can be a nuisance. Does it buzz or beep when it runs out of paper? If it doesn't, you might lose valuable information.

Some printers also have a special self-test feature, which at the touch of a button prints all of the printer's available characters. Some printers can even print characters upside down or sideways. Ask for a complete demonstration before you buy.

Printer accessories are also available. These include sound-absorbing covers, special tables, and so on. All add convenience but also add expense. One excellent investment, though, is a dust cover. For about \$10 to \$15, it will keep problem-causing dust out of your printer's delicate mechanism.

Be sure the printer comes with a warranty. Because printers have many moving parts, they're more prone to problems than other computer hardware. The usual warranty period is 90 days, but some printers have a 1-year warranty.



Some sophisticated dot-matrix printers can produce amazingly detailed graphic images.

Printer Prices. Printers for personal computers can be put into three general price ranges: low (under \$500), medium (\$500 to \$1,000), and high (over \$1,000).

Many impact and nonimpact dot-matrix printers are available for under \$500, including the thermal and electrographic models. They're suitable for producing hard copies of programs, and many do an acceptable job on minor word processing chores.

Printers in the \$500 to \$1,000 range are the most popular. They include fast dot-matrix and some of the slower letter-quality printers.

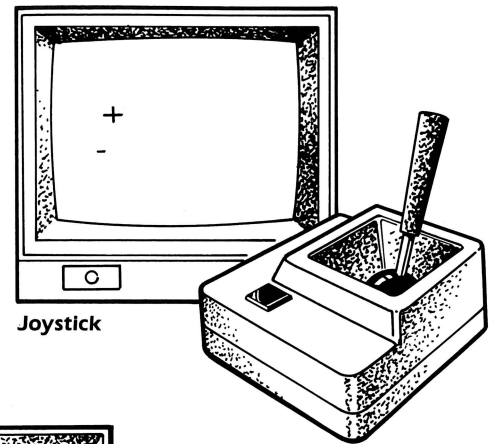
Printers that cost more than \$1,000 offer impressive print quality and speed, but they're too expensive for most home computer users. Unless you require the very best in hard copy, you're probably better off with a less expensive printer.

Just as personal computer technology is progressing at a rapid rate, printers too are evolving. Many of today's medium-cost units actually have their own built-in microprocessors that control the printing process. Prices are falling rapidly, particularly for daisy wheel printers. Machines that a short time ago would have cost \$1,000 are now \$500 to \$700. There are indications that new models will be available soon for \$300 to \$500. These machines feature all the capabilities of more expensive business models, but they are considerably less expensive. The tradeoff, though, is that they are also among the slowest units on the market.

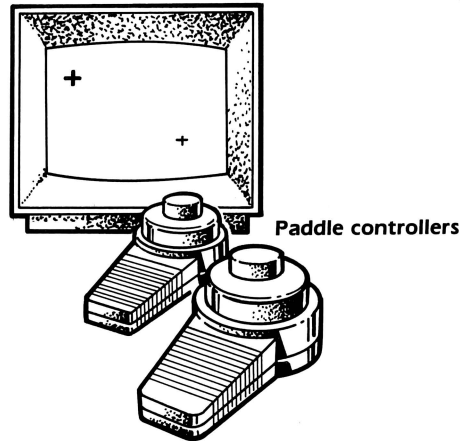
JOYSTICKS AND OTHER GAME CONTROLLERS

Many of the fast-action video games in arcades are played by moving the handle of a lever—a *joystick*—to change the position of an object on the video display screen. This input device for a home computer is like a smaller version of an airplane control stick. It is usually mounted in a small box that you hold in your hand. The box often has a button for firing missiles or releasing bombs during the game. Joysticks usually cost about \$20 to \$25 per pair, although more expensive models are also available.

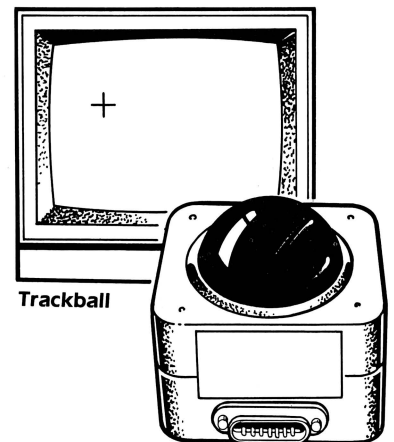
Most home computers have a place to plug in a joystick cable. Games for two players usually



Joystick



Paddle controllers



Trackball

Game controllers are used not only in a variety of computer games, but also in many educational and other software programs.

require two joysticks. You can play most computer games without a joystick by using certain patterns of keys, but the keyboard sometimes isn't as fast, as realistic, or as much fun.

The *game paddle controller* is a similar input device. It is capable of moving an object on the screen in only two directions (such as up and down or left and right). It is more limited than the joystick, but it is also less expensive. The

trackball, a faster-acting input device, is about the same size as a joystick, except you move a ball rather than a stick. Like a joystick, a trackball moves an object on the screen in all directions. Trackballs are somewhat more complicated than standard joysticks and are also more expensive, generally costing about \$40.

MODEMS

At one time or another you may find you want to use your home computer to "talk" with friends, get information from a computer database, or transmit data to another computer system. This is when you need a *modem* (short for MODulator/DEModulator), an input/output device that lets you link your home computer with other computers using a phone line.

A modem puts a world of information at your fingertips. It lets you use the many computer information services for obtaining news, weather, airline schedules, and other information. In fact, you can even exchange messages via electronic mail with other home computer users anywhere in the world. A modem converts the binary data your computer uses into tones that can be sent over phone lines. At the other end of the line, another modem converts the tones back into binary code so the other computer can understand the transmission.

Basically, there are two types of modems: acoustic couplers and direct-connect modems. An *acoustic coupler* is a small box with rubber cups designed to hold your telephone handset. You dial the number, and when the connection is established, you place the handset into these cups. Then your computer can "talk" with the other system.

Direct-connect modems hook between your phone and the wall jack. With some, you must manually dial the number and then flip a switch from "talk" to "data." Most of the direct-connect modems available today, however, are software programmable and interface directly with your computer. With these, calls can be placed directly from the keyboard, with the computer controlling the operation.

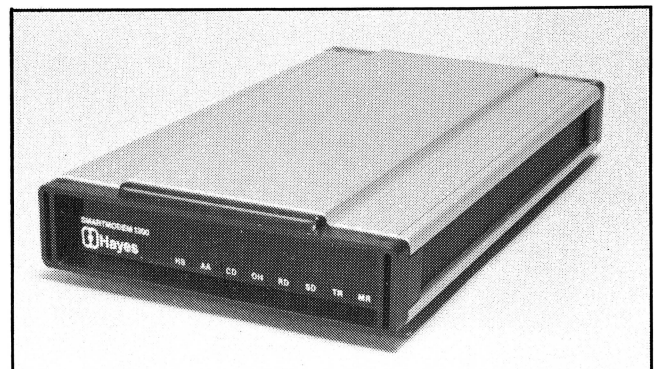
Modem prices vary greatly, from about \$100 to \$600 or more. Acoustic couplers are generally less expensive. Direct-connect units usually cost more because they require more circuitry. The

most expensive modems are those that transmit and receive information at higher speeds and those that dial automatically. The automatic-dialing modems are becoming smarter all the time. Some will not only dial but also store a list of frequently called numbers; all you have to do is pick out the number you want from the computer's memory. Further, these devices take data input and re-dial busy numbers until the other system is reached.

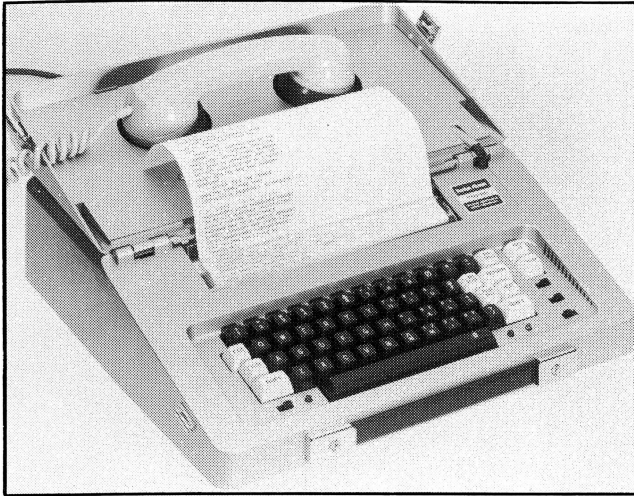
Not all of these functions are controlled directly by the modem. You may also need to buy a special software program—called a *terminal program* or *communications program*—in order to use a modem with your computer. These programs enable your home computer to act as a remote input/output terminal and let your system "talk" with other computers. Without it, there would be no way to capture or control what is being sent or received. Check with your dealer on the exact program you need for your modem and computer; there are many such programs available.

TERMINALS

If you intend to use a home computer mainly to work with a mainframe or to access computer information services, you might consider just purchasing a terminal rather than a full home computer system. *Terminals* are input/output devices designed solely for communicating with a mainframe system, which may be at a completely different location or just in another part of the same building. Terminals are seen frequently in offices. They are the computer devices that enable service representatives at utility companies to quickly locate your account or look up a phone number.



With a modem, you can link your computer to huge databases to obtain a wealth of information on many topics.



Some terminals for working with computer information services include a built-in modem and printer.

Essentially a terminal consists of a keyboard and a video display. There are two kinds: the so-called *dumb terminal* has just the minimum circuitry needed to type in information and receive a reply on a video display; the *intelligent* or *smart terminal* has built-in memory. Some smart terminals have one or more self-contained microprocessors and can do many of the same things a small computer can do.

Terminals range in size from small handheld units—designed to help salespeople call in orders from pay phones—to large and very expensive models that rival home computers in power. The costly terminals are designed to take the place of the keyboard and video display screen in high-priced computer systems. They are often used to allow several people (like airline reservation clerks) to use a mainframe system at the same time. This process is called *time-sharing*, a common and widespread practice that requires sophisticated software. Although time-sharing is mainly designed for large computer systems, some of the more expensive personal computer systems—those in the \$5,000 to \$10,000 range—are available with additional terminals that include a microprocessor, memory, and other circuitry. With one or two additional terminals, your business system can become a small network.

The main advantages of a terminal are its simplicity and cost, which usually is less than the cost of a home computer system. But consider getting a terminal only if you're sure all you want to do is get information over the phone. A home computer is an immensely more pow-

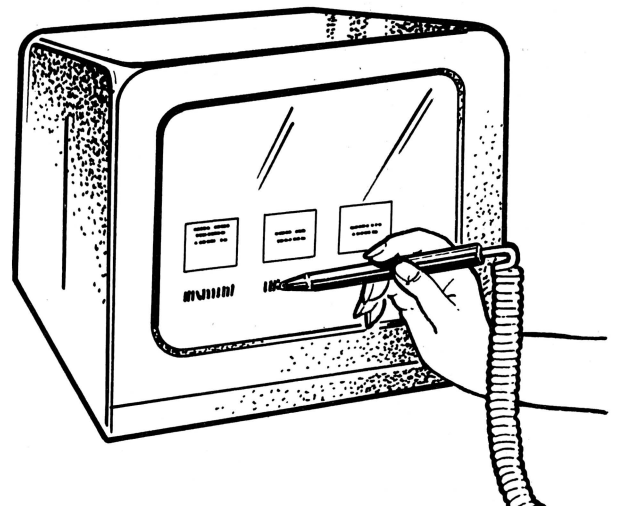
erful tool than a terminal. With a modem connecting it to a mainframe system, a home computer becomes a terminal as well. To do this, software in the modem shuts down the home computer's microprocessor and puts the system into a terminal mode. You can, for instance, even have your system print out data transmitted from another system.

PERIPHERALS FOR GRAPHICS APPLICATIONS

Two peripherals that are especially useful if you plan to use your computer for graphics applications are light pens and plotters.

Light Pens

A *light pen* looks like a thick ballpoint with a cable at one end that connects it to the computer. It enables you to change text and graphics on the screen without using the keyboard. The light pen has a tiny sensor at the tip that detects light areas on the video display screen. The text and graphics produced on a screen are produced the same way as an ordinary television picture: a beam of electrons sweeps across the screen, causing areas of it to light up. Because this beam is precisely controlled and repeatable, it's possible for the computer to determine exactly where the tip of the light pen is pointing. Using a light pen along with the special software it requires, you can program a computer so that instead of having to type in commands on a keyboard, all you



A light pen lets you communicate with the computer without typing. All you do is point to the video display screen.

do is point the pen toward a word or drawing you want the computer to act on. You can also use a light pen to draw graphics on the screen. Light pens range in price from about \$25 to about \$125, but remember that you also must buy the special software that enables the computer to respond to a light pen.

Plotters

A *plotter* is a special kind of printer that produces graphic designs. A plotter enables a computer to draw diagrams, designs, patterns, and symbols. Plotters include special writing devices similar to ballpoint pens or felt-tip markers. They can even print perfectly formed numbers, letters, and punctuation marks, all on regular printout paper.

Plotters were once very expensive, but their prices are falling fairly quickly. For between \$1,000 and \$2,000, you can buy a plotter that can draw with as many as six colors. In fact, some microplotters—capable of using four colors—can be obtained for some tiny handheld computers for under \$300. If you can use a plotter's graphics capabilities, which are particularly appropriate for business applications, you might want to consider this peripheral at some point.

POWER PROTECTORS

Most peripherals do specific jobs, but there are some that help keep your computer working at these jobs. One is the *line filter*, an inexpensive device costing between \$10 and \$15, which protects your computer from voltage surges and interference caused by appliance motors. This is important because an abrupt change in the voltage level can damage a computer system; the line filter offers protection against this kind of damage. A line filter is a form of insurance well worth considering.

Another power protector is called an *uninterruptable power supply*, or *UPS*. The UPS is a failsafe device for supplying electricity to a computer during power outages; it provides electricity long enough for you to save the volatile data stored in the computer's RAM. Without a UPS, all the data being worked on would be lost if the power were to fail or if the machine were accidentally unplugged while in



A plotter is a special printer that draws on the paper with pens or markers to produce graphs, charts, and other images.

use. Until recently, the least expensive UPS cost more than \$2,000, but these devices are now available for \$400 or less. As prices decline further, you may want to consider investing in a UPS. Manufacturers may also start building this protection into their computers.

A similar device is a *backup power supply*. The key difference between the UPS and the backup power supply is in their functions. Where the UPS is designed to provide about 20 minutes worth of alternating current, a *backup power supply* provides power to a specific part of the computer—a clock, for instance—for an extended period of time, such as when the power is turned off. The backup power supply is usually a small battery, which either may be recharged by the computer itself or may be a special battery designed for long-term use.

A different type of backup power supply is that featured with some portable computers. These are actually batteries that supply enough power for two or three hours of computing to those portable computers that can operate on battery power.

ADDING MEMORY TO YOUR COMPUTER

Up to this point, we've been talking about computer add-ons—accessories you can use with a computer to perform certain tasks. There's one other important kind of peripheral—extra memory. Adding extra memory to your system gives it more computing power.

Even though the price of RAM is rapidly falling, many low-cost home computers come with just a minimal amount of memory, some with less than 8K. This level substantially limits the quantity, sophistication, and variety of the programs a system can run.

The solution to this is to add more RAM. The more RAM a computer has, the more software it can run because more involved programs take up more memory space. It's best to buy a computer that has enough memory to meet your needs, but depending on the computer, more memory can usually be added.

Although the minimum level of memory your computer should have is probably 16K—or just over 16,000 individual locations for information storage—48K is even better. If your system is capable of holding it, 64K is better yet. If your computer doesn't have the amount of memory you need for the programs you want to run, you can usually add memory in one of several ways.

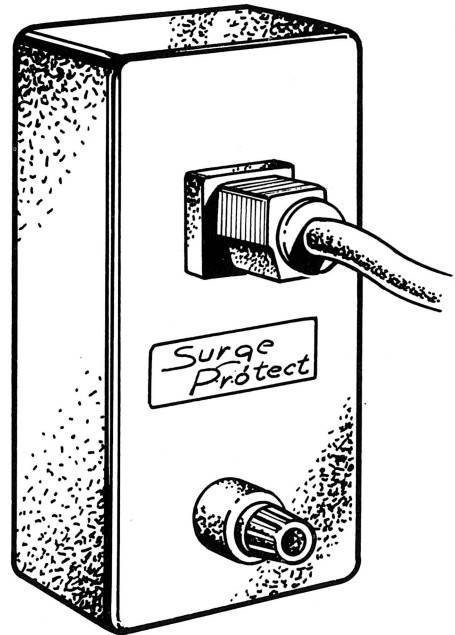
You can sometimes add memory by using plug-in cartridges, which look like those used for home video games. Although this is a convenient and quick way to add memory, if your system has too many boxes and cartridges sticking out, the combination can get in the way of your computing.

Additional memory may also come on a *card* or a *board* (both terms mean the same thing). These are small pieces of plastic, about the size of a playing card, onto which additional electrical components have been etched or printed. Boards or cards are installed into *slots* that have been built into the computer for this purpose. These slots are usually found under the computer's cover and may not be accessible to the user. *Ports*, on the other hand, are connectors on the outside of the computer case and are more accessible. Ports are usually provided for each of the peripherals most frequently used with a particular computer. Ports are usually provided for joysticks, disk drives, printers, and the like.

Many companies will install additional memory, but this requires either bringing the computer to a dealer or sending it back to the manufacturer if the process requires installing memory chips in a new circuit board and wiring it in. Some companies also sell plug-in memory

boards for certain computers. The Apple and the IBM Personal Computer, for instance, have special slots for these plug-in boards; all you do is open the machine's cover and plug the memory board in. Only a few home computers are built to work this way, however. Some machines are not designed to be opened at all, and you may void the warranty if you open the cover of one intended to be kept closed. It's best to consult your dealer if in doubt.

The cost of memory expansion varies from system to system, but memory prices in general continue to fall. A 12K RAM expansion (from 4K to 16K, for instance) may cost about \$50; a greater expansion may cost as much as \$200. Unfortunately, you can't shop around much; the price depends on the specific computer system. Prices vary from manufacturer to manufacturer, and the most reliable way to add memory is to go back to the manufacturer. You might be tempted to get around the installation costs of additional memory by buying the chips advertised in computer magazines, but we don't advise this. Installing memory circuitry requires a great deal of electronics knowledge, and this may be another way of voiding the computer's warranty. Further, the bargain chips might not even work. Your best choice is to stay with your computer manufacturer's product for adding memory to your system.



Line filters and surge protectors prevent damage to the computer when a voltage surge occurs.

CHOOSING YOUR HOME COMPUTER



If you've read this far, chances are that you are interested in buying a home computer. You have considered the benefits and your bank balance and concluded that you want to invest your time and money in this fascinating phenomenon—now or in the future. Once you have made this decision, you are faced with a question: "Which one should I buy?"

In order to answer this question, there are two other questions to think about: "What do I want to do with it?" and "How much computer power do I need?" The variety of hardware and software alternatives available may seem bewildering, but answering these questions can help you determine what you want and need. Many computer experts advise deciding on the applications first—what kinds of software programs you want to run—and then choosing a machine that will run those programs.

Fortunately, buying a home computer system is a lot like buying quality camera or stereo equipment. You can start small and then add software and peripherals as new requirements arise and your finances permit. However, you have to watch what you buy. The peripherals and hardware sold by Company X may not work on a system sold by Company Y. If you plan to expand your system at some point, it's wise to buy a computer for which many peripherals and a great deal of software are available. You will usually be safe if you stay with the major brands. We will discuss several lines of computers later in this chapter.

When you make your first purchase, it's a good idea to buy only as much computing power and accessories as you need at first, especially since prices on peripherals such as disk drives and printers are expected to keep falling and will probably be even lower in a year or two. On the other hand, you can often get a better deal by buying a complete package all at once. Package arrangements include a variety of options, accessories, and software, in addition to the basic computer. Complicating your choice is the rapid growth and change in the home computer market. New computers, peripherals, and software are appearing all the time.

In this chapter, we'll look at some popular and representative personal computer lines. By knowing about the capabilities and features of

specific machines and systems, you'll be better prepared to compare features when you start shopping for your own home system.

WHAT DO YOU WANT IT TO DO?

When shopping for a home computer, your most important consideration should be what you want to do with it. The answer to this question will narrow down your choices considerably.

If you're planning to use a home computer for games, education, some home finance, and maybe a bit of BASIC programming, then one of the smaller, less expensive machines will probably be all you need. They are true computers, with a great deal of software available, but they often don't have large memories, full typewriter keyboards, or the ability to expand with lots of peripherals and accessories. But for basic uses, they're fine.

Although low-priced computers are fine for starting out, many people find that the more they learn about and use a computer, the more they want to do with it. Before long you may want to begin using your computer for word processing, sophisticated financial planning, and other tasks like handling club mailing lists and newsletters. If there is a possibility that you will soon want to get into such applications, buy a computer for which a wide range of peripherals and additional memory are available. You don't have to invest a lot in your system at first, but you can purchase one that has the ability to expand if and when you're ready.

Another important consideration is the amount of time you will be using the computer. If it will likely be on a daily basis, you should probably consider a more sophisticated system that includes a full typewriter-style keyboard and a video display designed to reduce eyestrain.

FACTORS TO CONSIDER

Despite the advertising literature, all home computers do basically the same things in the same way. Key differences are in the efficiency of the system, the quality of construction, and the ability of the system to do the kinds of work you want it to do.

One of the first decisions to make is whether you want a portable or a desktop model. Will you be carrying the computer around with you or using it only at home? There are many other factors to be considered as well. To help you reach a decision, we've compiled the following questions to give you some ideas of what to look for. Note, too, that there isn't one ideal home computer, just as there isn't any one ideal house or car. Computer features vary greatly from one model to another. When it comes to making the final choice, you have to decide what's best for your needs.

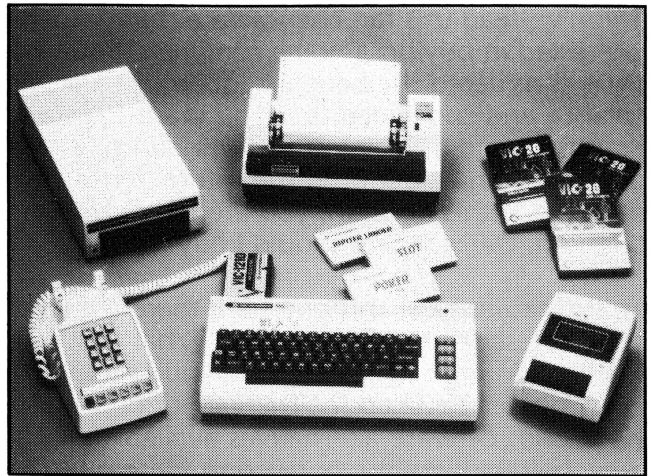
Is the Computer Easy to Use? There are several factors to consider here. Does the keyboard have a standard typewriter-style keyboard, or are the keys arranged differently? If you are used to a standard typewriter keyboard, you'll want a computer arranged in that familiar fashion. Also be sure that the keys are the right size for your fingers.

If you are buying a video display, or if a video display is built into the computer console, make sure the screen is easy to read. If you are planning to buy a system that hooks up to a television set, make sure you see what the picture looks like on a TV. Characters on a TV screen will not be as sharp as on a video display or monitor. In either case, avoid a screen that's hard to read and hard on your eyes. If you have only one TV, you may have additional reasons for wanting a separate monitor.

How Much Memory Does It Have? For most home uses, you'll need at least 16K of RAM; this, however, is the minimum. For better efficiency and to run many programs, you will need 32K or 48K. The ROM capacity is less important, but be sure the computer is programmed to understand BASIC. You may want to add memory later on, so check whether more RAM can be added and how much RAM can be added.

Is a Wide Range of Peripherals Available? Make sure you can upgrade your system after you buy it. Options available to you should include:

- A cassette tape recorder
 - Floppy disk drives
 - A printer
 - Additional memory
 - A bigger or better video display
- Other useful accessories include dust covers,



If you buy a computer that offers a variety of software and peripherals, you'll be able to add to your system later.

stands and tables, and tape and disk file cases. Depending on your own interests, you might also want to check if specialized accessories (like a modem or a speech synthesizer) are available.

Is Software Readily Available? Consider the amount and types of software available for a system. Is a wide range of software available? Does that software suit your needs? If you are going to use the computer for a home business, for example, and what's available with it is mostly educational or game software, you should look at other computers. Remember, decide on software applications before you decide on a machine.

What's the Documentation Like? Although the day may be coming, buying a computer is not yet like buying any household appliance. You still can't just plug it in and use it, as you can with a toaster. Instead, you have to follow the instructions, called the *documentation* in the computer business. The instruction manuals that come with the computer should be easy to follow and written in plain English, free of technical jargon that assumes some computer expertise. No matter how good a computer is otherwise, it's useless if you can't figure out how to use it.

Does It Have a Good Warranty? The company from which you buy your computer should stand behind its product. One clue to the depth of this support is the length of the warranty. This varies from company to company. Most computer warranties are for 90 days, although there are some companies that

will back their equipment for up to two years. Computers are complicated gadgets, and you can be sure that at some time something will go wrong, particularly if you use it extensively. This is when you need a good warranty. Remember, too, that some kind of warranty is required by law.

Is the Manufacturer's Reputation Good? Just as some warranties are better than others, some manufacturers are better than others when it comes to helping you with problems that may come up with their computers. Talk with people who own home computers. Word of mouth is usually the most reliable indication of how good—or bad—a product is. A good source of advice on manufacturer reputation is a local computer club or users' group.

Keep all these considerations in mind as you read the following descriptions of popular lines of computers. We'll look first at some of the popular desktop models. Then we'll take a look at a few of the portable computers available.

DESKTOP COMPUTERS

The desktop home computers included here are examples of some popular models made by several major manufacturers. They are listed in alphabetical order by the manufacturers' names. Some of these companies make computers for both home and small-business use, and some computers are suitable for both applications. All prices given are the manufacturer's suggested retail prices at the time of publication. However, new computers are being introduced all the time, and the prices and specifications given here may change quickly. Remember, too, that list prices are often discounted. In many cases, manufacturer rebates and dealer discounts can lower retail prices considerably. Use the information that follows as an introduction to the kinds of features and the capabilities now available.

Apple

The personal computer field was pioneered by a number of companies that sold kit computers to electronics hobbyists, and Apple Computer was one of these firms. From its start in the mid-1970s, Apple has become one of the world's largest personal computer companies.

Its famous Apple II was a best-selling computer, and its newer Apple IIe has been a similar success.

The Apple IIe. Priced at about \$1,295, this successor to the Apple II and the Apple II Plus retains the same look as its predecessors—a long, narrow keyboard designed for connection to an external video display device, either a TV or a monitor. The Apple IIe comes with 64K of RAM as standard, so it can handle some complicated chores. It can be expanded to 128K of RAM. It retains a connection for a cassette recorder, but disk drives are more popular with the Apple.

There are more accessories and software available for the Apple than for any other home computer. An entire industry grew up around it. Thousands of programs and hundreds of add-ons are available for the IIe, not only for use in homes and schools, but for business, industrial, and scientific applications as well. An Apple is as at home in a physics lab as on a kitchen table.

The IIe keyboard has 63 keys arranged like a standard typewriter keyboard. It produces both uppercase and lowercase letters. It generates a standard character set in a 24-line by 40-character display.

If you want a wider display than the standard 40-character line, you can do this by purchasing an accessory card—an additional bit of circuitry that is easily installed in the computer. This card enables the IIe to generate the 80-character-wide display that is standard for business computers. The IIe produces a high-quality color display in up to 16 colors. It also has a built-in tone generator.



The Apple IIe computer

One useful feature of Apple computers is that their circuitry is easy to reach, a plus when it comes time to expand the system. Most computer companies build their products so you won't be tempted to look inside. However, when you pop open an Apple's lid, you see seven expansion slots that allow not only upgrading the display, but also adding memory and other peripherals.

Apple and other companies sell a variety of accessories, including additional RAM, 80-character display adapters, voice synthesizers, digital clocks, modems, joysticks, and more. Apple offers a disk drive (including the required interface card) for about \$545. A dot-matrix printer is available for about \$675; the interface card required to hook up the printer costs about \$195.

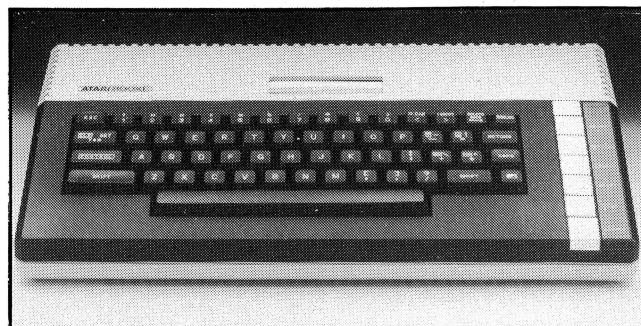
The Apple III Plus. In the middle of Apple's line with a base price of about \$2,995, the Apple III Plus is aimed at business and professional applications. It comes with one disk drive and 256K of RAM as standard.

The Apple Lisa. A top-of-the-line business computer, the Apple Lisa offers a great deal of power as well as an innovative feature called a *mouse* (a device for moving text and graphics around without using the keyboard).

One of the first systems to take advantage of an advanced microprocessor, the Lisa comes with 1 megabyte of RAM. (A *megabyte* equals 1024 kilobytes, which is more than a million bytes.) This large amount of memory is a tremendous advantage for the user, particularly for business applications.

That the Lisa is easy to use is evident from the pictorial nature of its programs. Rather than words, pictures of the various tasks the program can perform appear on the screen. The *mouse* is a tabletop controller that you use to move the cursor to the picture of the action you want performed.

The Lisa is a very innovative system and likely points in the direction computers will go in the future. As you might expect, this kind of power and usefulness is expensive. Aimed at the business market, the Lisa carries a price tag of about \$6,995; this price includes the keyboard, monitor, mouse, two floppy disk drives, and a 5-megabyte profile disk.



The Atari 600XL and 800XL computers

Atari

Long the leader in video and arcade games, Atari is one of the largest manufacturers of microprocessor-based home electronics and entertainment products. The company has sold millions of home video game systems, which are essentially sophisticated computers without a keyboard. It has recently revamped its home computer line and added several new models.

The Atari 600XL. Called a "beginners model," the 600XL comes equipped with 16K of RAM, which can be expanded to 64K with an additional memory board. At about \$199, this low-cost home computer has a 62-key, typewriter-style keyboard that includes an international character set (this means it includes special symbols such as those necessary for mathematics). The keyboard allows full-screen editing and a deleting backspace key, plus some special-purpose keys. Various expansion ports are provided for adding accessories.

Despite its low cost, the 600XL is capable of producing powerful graphics and sound effects. It offers a full spectrum of colors and a 24-line by 40-character display. It easily hooks up to any home television set. When used with a cassette recorder, it can accept a computer program from one track and audio signals from another, making a full sight-and-sound show possible.

A wide variety of available accessories can turn the 600XL into a powerful system. These include cassette recorders, the Atari modem for about \$200, three different kinds of printers and plotters that range in price from about \$300 to \$550, and a disk drive for about \$450. The 600XL features a port for plug-in cartridge software. A wide range of business, educational, and game software is available, not only in cartridge form, but also on cassette tape and disk.

The Atari 800XL. The 800XL is basically the same machine as the 600XL, except that the 800XL has more memory. The 800XL comes with 64K of RAM as standard. Thus the 800XL can handle more sophisticated tasks without adding memory. It also uses the same peripherals as the 600XL. Available for about \$300, the 800XL can become the basis of a very powerful home computer system.

The Atari 1400XL and 1450XLD. Built-in peripherals set these apart from other Atari computers. Both have 64K of RAM and feature built-in modems that allow communication with other computers and access to information services via the telephone. A voice synthesizer translates commands into speech, and an option pending will enable the computer to talk with you. The 66-key, typewriter-style keyboard features a HELP key and four special-function keys that simplify the use of certain programs.

Both the 1400XL and the 1450XLD have built-in BASIC. Due to their powerful memories, they can handle word processing, accounting, and many other home and small-business applications. The 1400XL and 1450XLD can hook up to a TV for video display and can produce high-level graphic displays in a full spectrum of colors. Sound effects can be produced with a built-in tone generator.

The key difference between the 1400XL and the 1450XLD is that the 1450XLD comes with a disk drive. This drive stores up to 254K of information and is faster than standard Atari drives. Both units feature plug-in cartridge slots. A wide variety of home, business, educational, and games software is available on cartridges as well as on cassette tapes and disks.

The 1400 series uses the same peripherals as the other Atari computer systems. A key item

to note about the Atari lineup is the ease of upgrading from one system to another. If you buy a 600XL and want to upgrade to an 800XL or a 1400XL, you can still use the same software and peripherals. This is something to consider when shopping for a computer.

Coleco

The Adam. This cleverly designed machine marks the entry into the computer market of a firm known as a major manufacturer of toys and video games. The Adam is a complete home computer package that sells for under \$700. It comes with 80K of RAM, expandable to 144K. The Adam features a built-in digital data pack drive—a high-speed cassette tape storage device capable of reading the Adam's specially formatted tapes. This system is sometimes called a "stringy" floppy because its storage capacity is much like that of a floppy disk; however, it uses a long tape "string" instead of a disk. The Adam system can also use plug-in software cartridges.

The Adam computer package includes a 75-key, full-stroke typewriter-style keyboard that can generate a 36-column display on a standard television set. The Adam can operate with either a color or a black-and-white display. Two built-in game controllers with joysticks double for entry of numeric data. The system is also capable of generating three-tone sound.

Adam is programmable in BASIC and has a built-in word processing program. It is option-



The Coleco Adam computer system, including a digital data pack drive, game controllers, and printer

ally compatible with the industry's coming standard, the CP/M control program. This operating system gives you access to a wide variety of specialized software. A standard printer is included in the price of the Adam, which gives you an entire home system in one package.

Commodore

One of the early home computer companies, Commodore introduced its first system, the PET, in 1976. Commodore now makes a complete line of personal computers, ranging from the highly economical VIC 20 to more expensive business-oriented systems.

The VIC 20. With a suggested price of \$195, this is one of the least expensive full-featured home computers on the market. As a result of dealer discounting and manufacturer rebates, it has recently been available for substantially less in many stores around the country.

The VIC 20 has a 60-key typewriter-style keyboard and is designed to be connected to any

television set. The basic model has only 5K of RAM, but this can be expanded to 32K. Pictures and characters can be displayed in up to 16 colors, and a variety of built-in tone generators create music and sound effects. The VIC 20 can display both uppercase and lowercase letters, however the screen is limited to 23 lines of 22 characters, which is less than that of many other home computers. Special editing keys allow you to insert and delete characters and words, and four special-function keys can be programmed to perform BASIC commands by hitting a single key. A wide range of software is available in cartridges, cassette tapes, and floppy disks. Games, family finance, education, business, and word processing software are all available.

Commodore produces a full line of peripherals, all of which are interchangeable among their machines. The graphic printer costs about \$399 and the disk drive about \$399. Commodore offers a special cassette recorder called a Data-sette, which sells for around \$75. You can also use some standard cassette recorders if you buy an adapter cable.

The VIC 20 has a port for plugging in a joystick or a light pen. Plug-in cartridges for expanding its standard 5K memory are available. Other cartridges allow you to connect special accessories, which include a modem priced at about \$99. An auto-modem is about \$149.

The Commodore 64. A more versatile home computer, the 64 is capable of not only games and educational applications, but also business and financial functions. With a list price of about \$595, the 64 features 64K of RAM, which is more than enough to handle just about the most sophisticated programs on the market. Like the VIC 20, the Commodore 64 can hook up to your home television set and can display pictures and graphics in 16 colors. Simple BASIC commands allow you to create graphics. Not only is the 64 capable of sophisticated graphics, but it also has three built-in tone generators for various sound effects.

The Commodore 64 is a far more sophisticated machine than the VIC 20, particularly for business applications, but the machines are similar in other ways. Both can handle uppercase and lowercase characters and both have the same type of special-function keys; however, the Commodore 64 can create a display of 25 lines



The Commodore VIC 20 and Commodore 64 computers.



The Epson QX-10 computer system, including disk drive and video display

of 40 characters, making it more usable for word processing. Further, a special add-in module enables you to use the 64 with a great deal of independently produced business software, along with that available from Commodore.

The 64 is a logical upgrade from the VIC 20 because both use the same accessories. If you outfit a VIC 20 system, including disk drives, modem, and printer, you can switch to the 64 without having to buy new peripherals.

The 64 and VIC 20 are capable machines, but they are not the only ones offered by Commodore. The company also makes a broad range of desktop computers designed specifically for business use. They include the PET 64, PET 4032, CBM 8032, Commodore Executive 64 portable, SuperPET, and others, plus even more peripherals.

Epson

Anyone familiar with microcomputers has heard of Epson America, Inc. This Japanese firm has long made a line of successful, high-quality impact printers for personal computers. Their entry into the home computer field with the Epson QX-10 came as no surprise.

The QX-10. Priced at about \$3,000, this is one of the easiest to use personal computers on the market. Though expensive, it offers a great deal for the money. It includes a standard 8-bit microprocessor, disk drives with a capacity of 340K per disk, 256K of RAM, and a high-resolution video display.

Another noteworthy aspect of the QX-10 is its VALDOCS system (for VALuable DOcuments). The VALDOCS system is an easy-to-use software package that combines word processing, scheduling, calculations, graphics, filing, and electronic mail. VALDOCS is a *menu-driven* package, which means that on-screen instructions and choices guide the user through the program. Though highly sophisticated, it has been designed for the computer user with no experience at all. Complementing this system is an innovative keyboard. Although it looks like a standard typewriter keyboard, it includes special keys that give you one-push access to features such as PRINT, STORE, RETRIEVE, and MAIL functions, as well as to file, applications, and typestyle controls.

Although the QX-10 requires a substantial investment, the system has many capabilities. You can file away recipes and easily handle family finances, as well as print business reports and letters incorporating graphics or special typefaces, and more. For both home and business use, this is a system to consider.

IBM

Everyone knows the IBM name. For years, IBM has been known for high-quality, innovative business computer products. The company waited to introduce its personal computers until it was sure there was a market for them. Now you can use an IBM at home as well as at the office.

The IBM Personal Computer. Commonly called the PC, IBM's Personal Computer was introduced in mid-1981 and was immediately regarded as one of the most professionally designed systems on the market. The separate typewriter-style, 83-key keyboard is one of the best available. It includes 10 special-function keys that can be programmed to perform a number of steps and a 10-key numeric keypad for entering numbers. All are repeat keys; when you hold a key down, it will repeat the character.

The computer carries its microprocessor, memory, and optional disk drives in a separate unit to which the keyboard and video display are attached with cables. This lets you set up the pieces of the system so they are most comfortable for you. Both monochrome—green-on-



The IBM Personal Computer, shown with IBM printer, disk drive, and video display

black—and color video displays are available, which display 25 lines of 80 characters in both uppercase and lowercase letters. The screen has an easy-on-the-eyes typestyle. With the color display, it offers 16 colors and allows mixing text and graphics on the screen.

For \$1,355 with 64K of RAM, the PC appears to be low priced, too; however, that price is for the basic unit, which includes only the keyboard and the 16-bit microprocessor. IBM has priced everything separately, and a system can cost anywhere between \$2,000 and \$4,500, depending on what you get. The PC's RAM can be expanded to 256K or more, and there are many accessories plus a great deal of software available from both IBM and independent suppliers. A dot-matrix printer costs about \$595. A 180K disk drive costs about \$289 (the required disk drive adapter is an additional \$220).

The IBM PCjr. Essentially, the PCjr is IBM's Personal Computer revamped primarily for home and school use. The PCjr is available in two versions. The basic model (about \$669) includes

the keyboard and the computer console containing 64K of RAM; this model is capable of displaying 40 columns on either a TV or a monitor. An enhanced version (about \$1269) includes the keyboard, the computer console containing 128K of RAM, and a floppy disk drive; it can display 80 columns on a TV or a monitor.

Both versions provide two cartridge slots that allow the use of cartridge software. Much of the software that has been written for the PC can also be used on the PCjr, and new software is being developed specifically for the PCjr.

The PCjr keyboard has 62 keys (compared to the PC's 83 keys), and these are chiclet keys, which many people believe are not comfortable to use for extended periods of typing. The PCjr's keyboard is cordless and battery powered; it transmits infrared signals and can be used as far as 20 feet from the computer console. When more than one PCjr is being used in the same room (as in a school), an optional cord can be used to connect the keyboard with

the computer console to avoid crossed signals.

Buyers of the basic model can later upgrade to the same features as the enhanced model by adding memory, an 80-column display card, and a floppy disk drive. Options available for either model include a connector for hooking up to a TV, a printer, a monitor, a modem, a disk operating system (DOS), cartridge BASIC, and joysticks.

The IBM Personal Computer XT. IBM also offers an upgraded version of the PC, which is called the PC-XT. The XT (for eXTended) is more powerful than the PC; it includes 128K of RAM and a 360K floppy disk drive as standard. It also includes a hard disk drive—for those super-fast megabyte-capacity disks. The XT uses the same basic components as the PC, but it has some additional features such as more expansion slots and an asynchronous communications adapter. All these features are included in the package price of about \$4,995. The XT is aimed at the serious business user.

IBM Compatibles. The shockwave that IBM sent through the microcomputer world was tremendous. As soon as their 16-bit personal computer was announced, other companies began coming out with "IBM compatibles," machines that have similar capabilities and can use much of the software for the IBM. This market is now full of computers that use the same microprocessor and a nearly identical operating system. Because they are aimed at the business market, all have prices that begin at \$2,500 and continue upward.



The IBM PCjr computer keyboard and floppy disk drive

Although these are not totally compatible due to technical differences, they all share the same general characteristics. First, they use a nearly identical microprocessor and feature 128K of RAM. Second, their internal organization is similar to that of the IBMs, and they use a nearly identical operating system. Third, they all come with one or two disk drives as standard. All produce high-quality video displays and offer color graphics capabilities, as well as high prices. The IBM compatibles come in a variety of desktop, all-in-one, and portable models.

Independent companies were the first to follow IBM's lead, but now many of the company's major competitors have also joined with similar units. Many seem to think that as IBM goes, so goes the microcomputer industry.

Radio Shack, Tandy Corporation

Once known as the friendly neighborhood electronics store, Radio Shack is credited with getting the home computer revolution rolling. The TRS-80 Model I, introduced in 1977, was the first generally available low-cost computer designed specifically for personal use. Tandy now makes a full line of personal computers and supports them with a wide range of accessories and software. TRS computers and software are available only in Radio Shack stores, but there are thousands of these retail outlets across the country.

The MC-10. While this is a tiny machine with a suggested retail price of only about \$120, it isn't a toy. It includes eight colors plus graphics and sound effects, hooks up to a color TV, and generates a display of 16 lines of 32 uppercase characters.

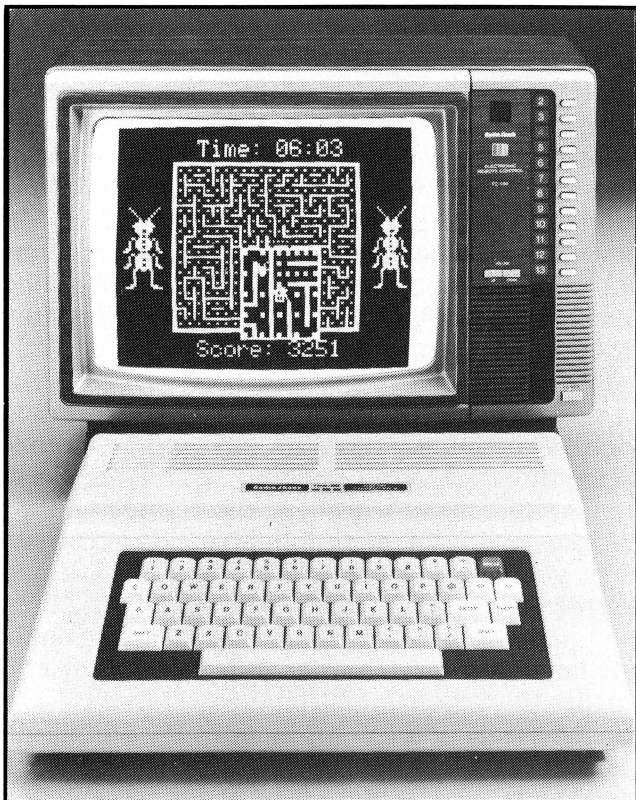
Its standard BASIC includes advanced features such as command keys that let you enter complete commands with just two keystrokes. Creating graphics is just as easy. By depressing the shift key with one of the graphics character keys, you can produce interesting, full-color graphic displays.

The keyboard is typewriter style, but it is much smaller than the standard, and therefore is somewhat limited for applications that require extensive typing. The MC-10 includes only 4K of RAM, but a \$50 module expands the internal RAM to 20K. A wide range of cassette soft-

ware is available, which plugs into a built-in port. Altogether, the MC-10 is a good game and learning machine.

The TRS-80 Color Computers. At about \$240, the TRS-80 16K Standard Color Computer II is a reasonably priced machine primarily for home use. Recently redesigned, its color has been changed from Tandy's traditional gray to off-white, and it now comes with a typewriter-style keyboard. This basic model has 16K of RAM, but its companion, the 64K Color Computer, offers an additional 48K of standard RAM. Either Color Computer can display 8 colors and 16 lines of 32 characters, but in uppercase characters only.

Disk drives and a cassette tape recorder are available for the Color Computer, but it can also use plug-in cartridges, and a wide range of them is available. A disk drive is available for about \$400. A color controller—or mouse—is available for about \$50. As with Apple's Lisa, the *mouse* enables you to control the cursor's position without using the keyboard. A wide variety of word processing, finance, and game programs are available on disk, cassette tape, or cartridge.



The Radio Shack TRS-80 16K Standard Color Computer II



The Radio Shack TRS-80 Model 4 computer

The TRS-80 Model 4. Radio Shack recently replaced its workhorse Model III with the more powerful Model 4. This machine is an all-in-one package. It has an attached keyboard and a built-in 12-inch black-and-white video display, and up to two floppy disk drives can be included in the spaces provided next to the screen. The Model 4 comes in different versions. The 16K Model 4 (without disk drives) runs about \$1000; if you decide to add disk drives to the 16K version, the first drive can be added for about \$649 and a second drive for about \$240. A 64K Model 4 that includes one disk drive sells for about \$1699. The 64K version with two disk drives costs about \$1999. If you start with the 16K version, it can be expanded to 64K.

In appearance, the Model 4 resembles an office desktop computer more than a typical home computer. The 70-key typewriter-style keyboard offers uppercase and lowercase letters, and the screen displays 16 lines of 64 characters, including special graphics symbols and special alphabets.

Both Radio Shack and independent producers supply a large variety of software for the Model 4. Accessories available include several models of modems, a control system for home appliances, cassette tape recorders, floppy disk drives, and one of the widest ranges of printers available for personal computers.

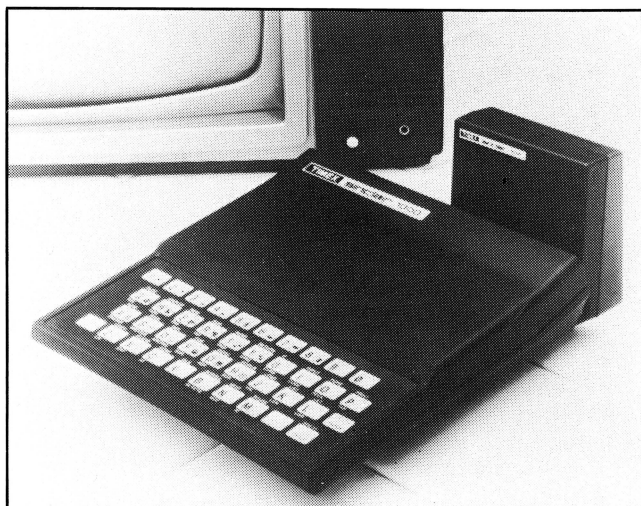
Other Radio Shack Computers. The Radio Shack computer line also includes two powerful personal computers designed for serious

business use. The Model 12 sells for about \$3,199 with one disk drive and for about \$3,999 with two drives; it has a wide range of professional software available. The Model 16 was one of the first small-business computers to use a 16-bit microprocessor (thus its name). An upgraded version, called the Model 16B, offers 256K of RAM and two microprocessors. Such power and its many capabilities are not inexpensive; the Model 16B is priced at about \$4,999 with one disk drive and \$5,798 with two disk drives.

Timex Sinclair

In 1981, the computer industry saw a first—the under-\$150 home computer. At that time, the price was phenomenal, and it became even more so as it continued to drop until it was the first home computer for under \$50. Made for Timex by Sinclair Research, a British electronics firm, more than a half million of these machines were sold in its first two years, but its popularity is waning as the price of other more fully featured computers fall to approach it.

The Timex Sinclair 1000. Available at thousands of retail outlets, from drugstores to discount marts, the Timex Sinclair 1000 was a refreshing change. Despite its tiny price, the 1000 is a powerful computer, not just a glorified calculator. Its 40-key membrane keyboard (a flat piece of plastic with imprinted keys) lacks the professional touch of other keyboards. But the computer has powerful capabilities, including moving graphics, single-key



The Timex Sinclair 1000 computer

entry of many BASIC commands, mathematical function keys, and an error-detection device. Yet it weighs only 12 ounces.

The 1000 can't produce color images, but it hooks up to either a color or black-and-white television set. The computer displays 24 lines of 32 uppercase characters. A cable is included for saving programs on most nonstereo cassette tape recorders. Software for the 1000 is available from independent companies and from Timex. Since most of it is on cassette tape, it's relatively inexpensive, usually about \$10 to \$20.

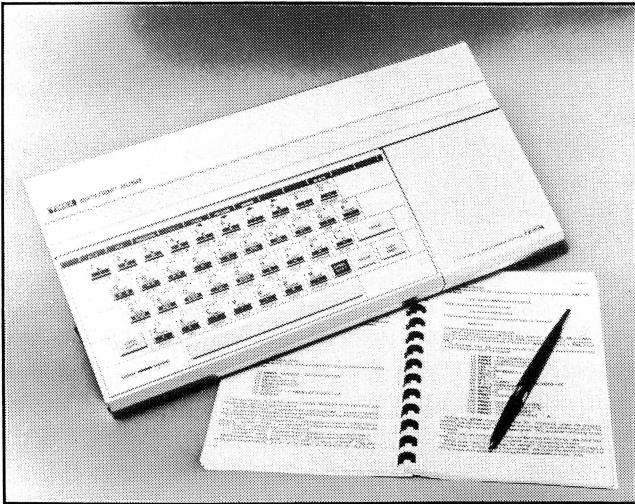
The Timex Sinclair 1000 is a basic learning machine. Its 2K of RAM limits its use. However, a RAM expansion module, available for about \$50, increases the 1000's memory to 16K RAM. Although it has qualified as a good computing bargain for the money, it is not a professional machine. Many people view it as a machine for getting a start in computing. A small printer, which works with all Timex Sinclair computers, is available for about \$100.

The Timex Sinclair 1500. This is a more powerful machine, and at about \$80, it is still one of the better bargains. With 16K of RAM, it is far more capable than the 1000. It also features a full keyboard of rubber-based keys, in the standard typewriter arrangement. Like the 1000, it features one-key entry of many BASIC commands.

Also like the 1000, the 1500 is limited to a black-and-white display and hooks up to a TV. It can use the same software as the 1000, and it can be upgraded to a 32K machine for about \$50.

The Timex Sinclair 2068. Billed as the first 68K RAM personal computer with a suggested retail price under \$200, the 2068 features high-resolution color graphics, programmable sound, and a full typewriter chiclet keyboard with uppercase and lowercase letters. It is priced at about \$200. The 2068 has a range of 16 colors and attaches to a TV for video display. Like other Timex Sinclair computers, it's limited to 24 lines of 32 characters.

Although almost as compact and lightweight as other Timex Sinclair computers, the 2068 is much more capable than the 1000 or 1500. It can be used with plug-in program cartridges as



The Timex Sinclair 2068 computer

well as with cassette tapes. Most software for the 2068 is on cartridge and is available for about \$15 to \$25.

The multifunction keyboard has uppercase and lowercase letters and 16 built-in graphics characters. The 2068 is not only a good machine for learning, but one that can fit into any home and handle minimal business chores.

PORTABLE COMPUTERS

A computer you can hold in your hand or slip into a briefcase might be considered even more "personal" than its desktop counterparts. There are now many different types of portable computers available, including full-featured portables, lightweight briefcase or notebook models, and handheld computers.

Transportable Models

The first portable computer on the market was the Osborne I, introduced in 1981. Although the company faced financial difficulties in 1983 and discontinued manufacturing their computers, the Osborne deserves recognition as the grandfather of a new family of computers.

Typically, transportable computers all have the same general characteristics as the Osborne: one or two disk drives, a small video display device, and packaged software. All of this is enclosed in a neat, carriable, but hefty package that weighs in at about 25 or 30 pounds. Al-

though these machines have handles, it is not recommended that you haul them about for long, unless you use a carrying device such as for luggage. These models were designed for the business traveler, but many have been purchased and are being used in homes for many purposes, none of which includes moving it frequently from one place to another. They can also be set up with a TV for a larger display.

The transportable field has grown since the Osborne was introduced. New firms have joined the market, and there are a variety of systems with both 8-bit and 16-bit microprocessors. Most also feature larger displays—seven or nine inches—and larger capacity disks than the original Osborne.

The KayPro II. This is one of many portable computers that followed in the wake of the Osborne I. At 26 pounds, the KayPro is more transportable than portable and fits better under an airline seat than on a lap. It's about the size of a small portable television set. The KayPro II has a full-sized, typewriter-style keyboard, 64K of RAM, two floppy disk drives, and a nine-inch green-on-black built-in display that is easy on the eyes. With it, you don't have to purchase a separate monitor, as you do with some other portables. This computer also features a standard 80-character by 25-line display. It is priced at about \$1,595.

The most striking aspect of the KayPro II—and its cousins—is the amount of software included in the purchase price. The machine comes with word processing and several business-related



The KayPro II portable computer

packages. This type of system offers, dollar-for-dollar, more for your money than most home computers.

Briefcase and Notebook Computers

There are also computers that are lightweight and small enough to truly be called "portable." Here are a few examples.

The Epson HX-20. The size of a three-ring notebook, the HX-20 is lightweight—about seven pounds. It has 16K of RAM (expandable to 32K), a 4-line by 20-character liquid crystal display, a 68-key typewriter-style keyboard, cassette tape or RAM storage, and battery power. The HX-20's standard RAM contains enough space to store hours of work, and it does not drain the battery to retain work in memory because tape storage is built in.

A 24-column printer is built in, but it is too small for much more than printing programs. Peripherals available include a modem, cassette tape recorder, and software. It sells for about \$795.

The Radio Shack Model 100. While it is a great deal like the HX-20 in size and appearance, the Model 100 differs markedly. It has a larger and easier to work with liquid crystal display of 8 lines by 40 characters. While the HX-20 uses a built-in microcassette, the Model 100 uses a full-sized tape recorder to store information. The Model 100 does not have its own printer, but it can be connected to an external one. It comes with 8K of RAM (expandable to 32K), and it is continuously powered by rechargeable batteries. Like other briefcase computers, the 100 features a typewriter-style keyboard. It also has special keys capable of acting as a numeric keypad.

The Model 100's most important feature is its built-in software: BASIC, a telecommunications program, word processing, a scheduler, and an address book. The Model 100 is aimed at the business user on the go. With its built-in auto-dial modem, it allows information transfer from anywhere there is a phone. The 8K version is priced at about \$799; the 24K version at about \$999.

Texas Instruments CC-40. Although the CC-40 looks like a glorified calculator, it is actually a



The Epson HX-20 notebook-size portable computer

full-featured home computer with a small but standard typewriter-style keyboard.

Powered by batteries, the CC-40 uses a low-power 8-bit microprocessor. It features a built-in one-line liquid crystal display. At a suggested retail price of \$250, this unit can use many peripherals and seems ideal for the person on the go who needs access to computing power.

Handheld Models

The notebook-size portables point to an interesting phenomenon—the miniaturization of all computers. These systems are becoming small enough to be carried anywhere. Portables have led to computers hardly larger than calculators.

Quasar/Panasonic HHC. The HHC (for Hand Held Computer) is a sophisticated portable with some features not available on many full-sized home computers. Manufactured in Japan, the HHC weighs only 21 ounces. Available with 4K or 8K of RAM, the HHC is expandable to a maximum of 104K by using external memory modules. Each module adds 16K, and as many as 6 modules can be added through an adapter. The HHC also features ROM capsules with applications software that can be installed in special sockets. The basic 4K model sells for about \$380, the 8K model for about \$480.

Unlike other handhelds, the HHC has a miniature 65-key typewriter-style keyboard with special-function keys. Its liquid crystal screen displays both uppercase and lowercase characters. A file system is built in, and BASIC is avail-



The Quasar HandHeld Computer system

able as an option. A clock controller system (alarm) is available. Quasar/Panasonic makes a line of miniature peripherals for the HHC: a thermal printer for about \$295, a television interface at about \$295 for black-and-white or color, and a modem for about \$250. Other peripherals include an RS-232 interface, memory modules, an EPROM programmer, and a 4-color plotter.

The HHC isn't the only handheld computer available. Handhelds with similar capabilities are available from Radio Shack and Hewlett-Packard, among others.

OTHER PERSONAL COMPUTERS

Many other companies are producing personal computers, including electronics companies like Zenith and Xerox, and other major computer manufacturers like Hewlett-Packard, Digital Equipment Corporation, and Wang. Many of their systems, however, are aimed more at the

business world than at the home market. We have discussed the most widely available machines and those designed for the first-time computer buyer. The information in this chapter should equip you to enter the personal computer market with some knowledge of what to look for, whether you decide to purchase one of the brands discussed or go for a more elaborate system.

WHERE TO BUY YOUR COMPUTER

Buying a computer may seem like a difficult task. There are so many choices and so many decisions to be made. One of these is where to buy it. As with systems, there are choices of stores, and your decision will affect both the price you pay and the service you receive.

Home computers are now sold almost everywhere—in discount department stores, in drugstores, and even in some supermarkets. There are many full-line computer centers, both

chains and independents. There are also mail-order computer dealers and a thriving market in bargain-priced used computers. Since each of these options has its advantages and disadvantages, it is wise to consider all the possibilities before buying.

Retail Department Stores

During the last couple of years, computers have become consumer goods. Like calculators and digital watches, home computers have taken their place on the shelves of retail stores across the country. Some mass merchandisers have opened computer departments, especially since the introduction of low-cost, retail-oriented computers such as the Commodore 64, VIC 20, the Timex Sinclair computers, and the Atari series.

Because they buy in volume, retail department stores often sell computers for less than the list price. When combined with special price incentives and manufacturer rebates, these prices can drop even more. Though price and availability are advantages to buying from a mass merchandiser, there are some disadvantages that should be noted.

A big problem is lack of knowledge on the salesperson's part. Computers are complicated, and it requires both knowledge and skill to sell them. Early attempts at selling home computers in department stores failed because the stores just displayed the computers next to the calculators and told the sales staff to "sell them." This is changing rapidly as computer sales grow; now many department stores are setting up computer sales departments staffed with trained salespeople.

Limited choice is another disadvantage. Retail stores cannot always carry a wide variety of computers or accessories, but this too is changing as home computers become more and more popular. However, you still may have to visit several stores in order to have a variety of machines to consider.

Another potential problem is service. Department stores usually have to send a computer back to the manufacturer if there are problems. Though factory service is the best service, it does take time. If you want to use your computer for business applications, you may not

want to wait the weeks that factory service requires. Even if time is not a factor, this is still an inconvenience. This situation is also changing as more computer manufacturers establish regional service centers or offer exchanges for nonworking machines.

Despite these disadvantages, buying a home computer from a department store can give you both a low price and a dependable product. If you want to buy locally and you have a good idea of what you want, a department store could be the place to go.

Mail-Order Houses

You can also buy an entire home computer system by mail and have it delivered to your door. If you know exactly what you want, this may be an option. The choice of products is extensive and the prices are usually the lowest. But there are some possible hazards.

First, make sure you buy from an established, reputable firm. Some mail-order companies announce spectacular deals on new products months before they are available. In response, hundreds of people send thousands of dollars and then may wait up to a year before the products are shipped. So, before you send your money in, be sure to find out about the reputation of the company. Read computer magazines, ask computer clubs, and try to find someone who has actually purchased a computer from the company.

Second, make sure you know exactly what you want when you order. Misplacing a digit on your order form or relaying the wrong product number over the phone can result in the wrong item. Be sure to check your order carefully before you send it in and follow all ordering and shipping instructions exactly to be sure your order is processed correctly.

Finally, note that you are responsible for checking out the system when it arrives. Most mail-order houses send out unopened boxes, straight from the manufacturer. Because of the computer industry's well-deserved reputation for reliability, this usually presents no problem and the system should work correctly. The manufacturer's strict quality control usually assures this. But what happens if the computer fails to work? Be sure you know the mail-order

company's policy on replacing defective equipment. Some companies will replace the equipment, but others require you to send it back to the factory for warranty service. This is, more often than not, a time-consuming process.

Computer Stores

Although department stores and mail-order companies are a good source for home computer equipment, a great many people buy their systems from established local computer dealers. Since the world's first personal computer store appeared in 1975 in California, two to three thousand others have opened in shopping plazas, in downtown business districts, and along major highways. Today, there are several computer stores in most metropolitan areas.

Whether you are buying or just looking, shopping at a computer store gives you several benefits. Because they specialize in selling computers, these stores not only display a full selection of computers, but also offer accessories, software, and excellent advice. You can compare the features and advantages of different computers and actually try out the machines you are interested in—the best way to shop for a home computer.

You will also usually find knowledgeable salespeople in computer stores. They can help you decide what you want a computer to do and offer advice on what you need to solve whatever problem or handle whatever applications you have in mind. Be wary, though, of stores in which the salespeople talk in computer jargon instead of understandable English.

Originally, computer stores catered to hobbyists—people who build their own equipment and then program it in assembly language. Some of these stores are still out there, but many have either changed or disappeared as computers have become consumer products.

Most computer stores carry a full line of peripherals and extras such as printers, disk drives, modems, and so on. They will usually be happy to let you try before you buy. Many have sample software packages up and running. Trying out these programs can give you an opportunity to use various machines even without previous computer experience. These

stores also offer special services, such as connecting a cable or helping to get a nonstandard accessory working. Be aware, though, that these special services will probably cost you extra.

Computer stores are the best sources for service and support on the machines they sell. Many have their own service departments. If you depend on your computer for business or professional use, fast service may be essential. Many computer stores will also offer you equipment to use while they service yours. Some stores offer computer courses for beginners, as well as courses for more experienced users needing to become familiar with particular software packages.

The main disadvantage to shopping in a computer store is price. You might be able to negotiate a 5 to 10 percent discount for a complete system, but in most cases, you will pay the full retail price. Because computer stores offer a great deal of postpurchase support and service, and because they cannot buy computers in thousands of units as a big retail chain does, their prices have to be higher.

As with any business, there are some unscrupulous operators. Check a store's reputation by asking friends or a local Better Business Bureau. Members of a computer club or users' group are also good sources of sound advice. Be wary, too, of going to a computer store for a lot of advice and help prior to purchase, and then buying from a mail-order or discount store. Understandably, computer stores are more interested in servicing and supporting paying customers, and they are unlikely to welcome you back if your mail-order special develops problems.

Despite their higher prices, computer stores offer numerous advantages, particularly if you want a sophisticated system for business applications. It's nice to know there is someone you can turn to if a problem crops up.

Used Computers

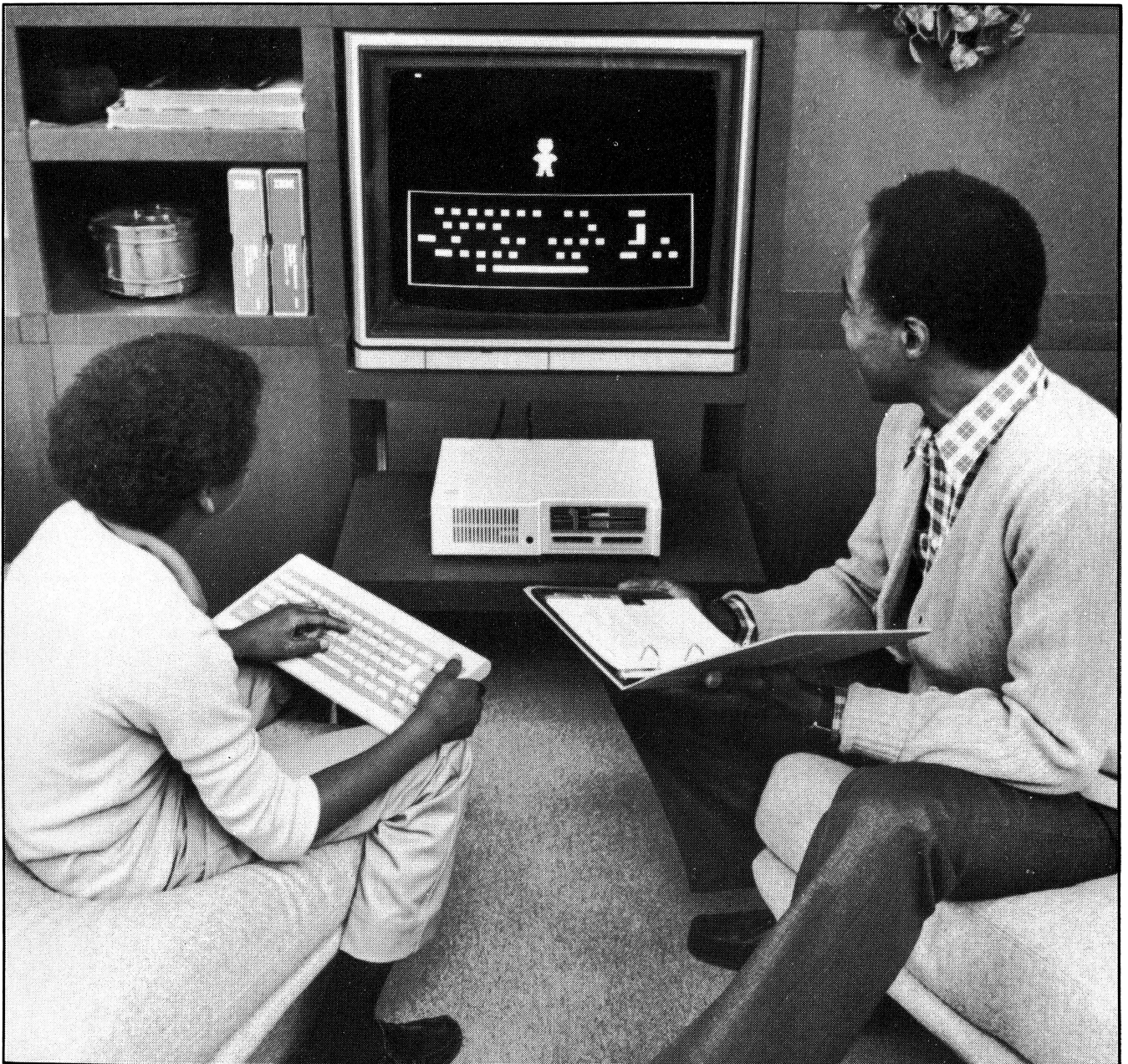
If your budget is tight and you want or need a better computer system than a low-priced entry-level machine, you might consider buying a used computer. There is a ready supply of these available because new models are ap-

pearing all the time and owners trade in or sell their old computers when moving up to new machines.

There are a number of outlets where you can buy used computers, and some computer stores sell units traded in on other systems. By inquiring at a local store or users' group, you may be able to find a reasonably priced system that will meet all of your needs. You can also find classified listings of used computers in computer magazines, in users' group newsletters, and even in the local newspaper. The problem,

of course, is the same as with used cars; you never really know what you're getting. A used computer may be a perfectly good machine, or it might have serious problems.

If you do decide to get a used computer, be careful! Warranty protection is nearly nonexistent on used computers, and they can be very expensive to repair. Any used computer you buy should be one of the well-known reputable brands (such as those mentioned earlier in this chapter). A couple of years ago, there were a number of computer lines that made a



If you put time and care into choosing a computer system, you can find a computer, peripherals, and software that will serve you and your family well when you bring them home.

brief appearance and then disappeared. Because their manufacturers are out of business, service on these computers is almost impossible to get. When buying a used computer, here's a good rule to follow: if you've never heard of the manufacturer, stay away.

Before buying a used computer, check it out thoroughly. Take along a knowledgeable friend, or perhaps a member of the local computer club, who can test the machine to be sure it's working perfectly. Computer stores are required by consumer protection laws to refund your money within a certain period of time if they sell a used computer that doesn't work. But this isn't the case with private sales: if you buy a lemon, it's yours. Thorough testing is essential to lessen this possibility.

Building a Computer

When the personal computer revolution began, small computers were regarded as toys for dedicated electronics hobbyists. They sent a check with an order to one of several computer companies and waited until a kit arrived. The kit was a box full of parts and a few pages of instructions. Putting the computer together was up to the purchaser's own tools and talents. Today, most computers are factory assembled and tested. But just as some people like to build radios, televisions, and other electronic products from kits, you may like the idea of building your computer. It isn't foolproof, but it can be done.

Building a computer and having it work the first time is a rewarding experience, but that's not always the way it is. You should not try to build a computer unless you've had previous kit-building experience. Start with a couple of low-priced kits—for a digital alarm clock, perhaps—to decide whether you want to

tackle a computer. You will have to know how to solder delicate components correctly, and you will need lots of patience.

The Heath Company is the world's largest manufacturer of electronics kits. Heath makes several computer kits that can save you 25 to 30 percent compared to a fully assembled unit. Their instructions and packaging have a well-deserved reputation for being the best in the industry, and they offer assistance to anyone who has problems building one of their kits. Be warned, though; this is a time-consuming and occasionally boring undertaking that could tie up your evenings for a couple of months. Even the best kit-builders make mistakes, and tracking down problems can be difficult. Mistakes are especially likely for the inexperienced and those in too much of a hurry.

Buying Right: How To Make Your Choice

Once you have decided to buy a home computer, it's wise to pause and rethink your choices. There's hardware and software aplenty out there, but somewhere there is a computer that is right for you. Take your time. A computer requires an investment of your time, money, and interest. Make sure you get the best possible for that investment because time and trouble before purchase will pay off when you start using your new computer. We've covered a lot of material in this chapter, but the right way to buy can be summarized in a few simple steps:

1. Decide what you want to do with your computer.
2. Find the models that will fit your needs.
3. Compare them by getting hands-on demonstrations.
4. Find out about service after the sale.
5. Then make your choice—and enjoy!

THE ABCs OF PROGRAMMING



If you're like most people who haven't had any experience with computers, you're probably worried about learning to program a home computer. But remember that you don't have to know how to program to use a home computer. You can buy an almost unlimited supply of ready-to-run software developed by expert programmers, or you can use written programs published in books and magazines. And commercial programs really lead you by the hand. When you run a packaged program, the computer will display instructions and ask you questions. All you have to do is type your answers or choices into the keyboard.

If you're not interested in learning how computers are programmed, you could skip this chapter. But before you do, think about this: you already have some programming experience!

Consider the pay telephone. Before you can talk with the person you want to call, you have to follow a simple set of instructions:

1. Look up the number of the person you want to call in a telephone directory.
2. Remove the telephone's handset from its cradle.
3. Insert the proper amount of money in coins.
4. Wait for a dial tone.
5. Dial the number you want, or push the proper buttons.

This list of instructions seems so simple that you're probably wondering why we've included it. The reason, of course, is that the instructions are like a simple program. Though it's designed for use by a person, it's just as much a program as the ones designed for use by computers. And telephone programs are not the only ones you use; you also use programs to operate many other kinds of devices and machines, ranging from washing machines and microwave ovens to thermostats and jukeboxes. And you use mental programs to perform everyday tasks such as cooking, writing a letter, playing a game, and planning a vacation.

Programming is really just logical thinking. It's an indispensable part of our daily lives. So why are so many people intimidated by computer programming? Maybe the science-fiction image of the computer as a super-intelligent electronic

brain is partially responsible for this feeling. But whatever its cause, the fear is ill-founded. Programming in today's computer languages is easy, and it can also be a lot of fun. By the time you finish reading this chapter, you'll be acquainted with the fundamentals of BASIC, the most common programming language—and the easiest—used for home computers. As you'll soon see, BASIC is simple enough that a beginner can start to write programs within a few hours—with or without a computer at hand!

GETTING DOWN TO BASIC

As we pointed out earlier, BASIC (Beginner's All-purpose Symbolic Instruction Code) is a high-level computer language that lets you use English words, phrases, symbols, and numbers to give orders to a computer. Like any other language, BASIC has a vocabulary of words, and these words have very precise meanings. Because it's a two-way language, BASIC can be used to simulate conversations between you and your computer. It also produces various messages that tell you when your computer is ready for new instructions and when you've given it incorrect instructions.

The best way to learn BASIC is to try some actual computer programs written in it. Although having a home computer in front of you would be helpful, you don't need one to learn. This chapter will teach you some of the basics of BASIC, with the help of an imaginary home computer. There are slight differences in the various versions or dialects of BASIC used by various brands of computers, but the version we'll use is representative of most.

If you want to try this out for real, go to a computer store, a library, a school, or a friend's home, anywhere you can find a computer to use for an hour or so. Some public libraries, for instance, have a computer room where, for a couple of dollars, you can use a computer, and possibly get the assistance of a consultant. You will be pleasantly surprised to see how easy this is to learn.

A Simple BASIC Program

Complicated notations and long strings of numbers are what occur to most people when the

word *computer* is mentioned. Let's work with a simple BASIC program to change that "number-crunching" image computers have.

When you first switch on a home computer, the video screen will display a brief message similar to this:

```
READY
```



READY, or a similar term, tells you that your computer is ready for instructions, beginning at the screen location indicated by the square symbol. The symbol is the *cursor*. It allows you to quickly locate where a character will appear on the screen after it has been entered from the keyboard. The cursor may appear as some other symbol instead of a square, depending on what computer you're using.

Now you're ready to type the following information into the keyboard of your imaginary (or real) computer. You must press the ENTER key after typing each line of the program. If you don't, the computer will keep waiting for more instructions. ENTER tells the computer, "That's it for this line; now be ready for the next one."

Now you could type in these two program lines, pressing ENTER at the end of each line:

```
10 PRINT "WELCOME TO THE WORLD  
OF HOME COMPUTING!"  
20 END
```

Did you make a mistake? No problem; just backspace to the error by pressing the key labeled with an arrow pointing to the left. Every time you press this key, the cursor will move one space to the left. When you reach the error, type in the correct letter or number. Want to retype a complete line? Just ignore the original line and begin a new line with the same line number as the one you want to replace; the computer will automatically erase the original line for you and replace it with the new line.

Finished? Believe it or not, you've just typed a genuine program into the computer. All you have to do to *execute* or *run* your program is to type:

```
RUN
```

Now hit the ENTER key. The computer will carry out the instruction in your program by showing on its screen:

```
WELCOME TO THE WORLD OF HOME  
COMPUTING!
```

This, of course, is a very simple program, but it does demonstrate several important rules about BASIC.

The first is that PRINT is a BASIC language term or statement that orders the computer to display everything—even spaces—enclosed by quotation marks following and in the same line as PRINT. You'll find PRINT statements to be among the most common of all BASIC operations.

The second rule is that a program should usually be concluded with an END statement. This prevents the computer from wandering down into the remnants of some other program that you may have previously entered into the computer.

The third rule is that the ENTER key must be pressed to load each line of a program into the computer's memory. This is very important. You can make it easy to remember by thinking of the ENTER key as the carriage-return key on a typewriter. In fact, some computer manufacturers label this key as RETURN or CR (carriage return).

Did you notice that the program consists of two lines of text and that each line is preceded by a number? Without the line numbers, the computer will not consider the information as part of a program.

Why are the lines numbered 10 and 20 instead of 1 and 2? They can, in fact, be numbered 1 and 2. It's customary, however, to number the lines in a computer program 10, 20, 30, and so on, because this gives you plenty of room to insert extra numbers or steps into the program if you have to later on. For example, you might want to add steps 11, 12, and 13, or steps 21, 22, and 23.

Let's try it. Type the following line into your real or imaginary keyboard:

```
15 PRINT "COMPUTERS ARE DUMBER  
THAN YOU THINK,"
```

Now type the word RUN and press ENTER. The screen will display:

```
WELCOME TO THE WORLD OF HOME  
COMPUTING!  
COMPUTERS ARE DUMBER THAN YOU  
THINK.  
READY  
■
```

Notice how the computer automatically inserted the new line into the correct place in your program? We know it did because the monitor's screen flashed the new line of type before displaying the word READY, indicating that it had reached the END statement. But we can prove it by using a BASIC command designated LIST. Type:

LIST

Now press ENTER, and the screen will display the complete program in numerical order:

```
LIST  
10 PRINT "WELCOME TO THE WORLD  
OF HOME COMPUTING!"  
15 PRINT "COMPUTERS ARE DUMBER  
THAN YOU THINK."  
20 END  
READY  
■
```

As you can see, using the statement LIST tells the computer to display everything put into its random-access memory. Moreover, the computer automatically processes the instructions in a program in numerical order—not in the order typed into the keyboard. As you'll see, this feature can save you lots of time.

So far, we've learned something about the following BASIC statements and concepts: line numbers, ENTER, PRINT, quotation marks, END, RUN, and LIST.

Now let's liven up the program and learn about several important features of BASIC by inserting a new line into our program. Type:

```
15 GOTO 10
```

Now press ENTER, type RUN, press ENTER again, and the entire screen will fill with lines that all read:

```
WELCOME TO THE WORLD OF HOME  
COMPUTING!
```

This new line has caused several major changes in our program. Let's cover each of them.

First, we've introduced GOTO, a new BASIC command. This statement in line 15 instructs the computer to immediately go to the designated line number, in this case 10, and do whatever is indicated. So GOTO sets up what's called a *loop*. The computer prints, "WELCOME TO THE WORLD OF HOME COMPUTING!" and then proceeds to the next instruction—which simply tells it to return to the first instruction. The result is an endless cycle as the computer continues to flash the specified sentence onto the screen.

The second thing we've done is to eliminate the step we had earlier added to the program—15 PRINT "COMPUTERS ARE DUMBER THAN YOU THINK." We did this by simply using the original step's line number for the new step. This caused the computer to automatically erase the old step and remember the new one.

Still another thing we did is to make the END statement irrelevant because the computer never gets to it. But we'll leave it in because we're going to change the program again later.

Incidentally, computer programmers call GOTO an *unconditional transfer statement*. This definition is necessary to distinguish the GOTO statement from the so-called *conditional transfer statement*, designated IF . . . THEN.

Confused? Just remember that GOTO means the computer has no choice; it must go to the indicated line number. A computer programmer would say that GOTO transfers program control to the designated line. IF . . . THEN, as you've probably guessed, gives the computer an option. If a specified condition is met, then program control is transferred to a designated line number. Otherwise, the program continues its normal, step-by-step, line-by-line execution.

Using IF . . . THEN

IF . . . THEN doesn't make much sense without an explanation, so let's insert an IF . . . THEN statement in our simple demonstration program

to see how it works. The screen of our imaginary computer is still displaying those rows of WELCOME TO THE WORLD OF HOME COMPUTING! so we'll have to press the BREAK key to stop the computer. Now let's type the following new steps into the keyboard, pressing ENTER after typing each line:

```
5 LET A=0
12 LET A=1+A
13 IF A=3 THEN 20
```

Now type RUN and press ENTER to start the program. The screen will display:

```
WELCOME TO THE WORLD OF HOME
COMPUTING!
WELCOME TO THE WORLD OF HOME
COMPUTING!
WELCOME TO THE WORLD OF HOME
COMPUTING!
READY
```

As you can see, adding the three new lines ordered the computer to print the WELCOME message only three times before stopping. Can you figure out how the new program works?

Don't worry if you're in the dark. We've introduced a couple of new BASIC commands, so let's explain them. First, type LIST and press ENTER to see the expanded program. The screen of the computer will display:

```
5 LET A=0
10 PRINT "WELCOME TO THE WORLD
OF HOME COMPUTING!"
12 LET A=1+A
13 IF A=3 THEN 20
15 GOTO 10
20 END
```

Let's assume that we've typed RUN, and that we're following the program a step at a time as it's processed by the computer. Here's an explanation of what happens:

```
5 LET A=0
```

This line introduces LET, another word in the BASIC vocabulary. It simply establishes a memory location designated by any letter of the alphabet, and assigns the number on the right of the equal sign to this location. In this case,

memory location A is assigned the value 0 (or empty) in preparation for what takes place in line 12.

```
10 PRINT "WELCOME TO THE WORLD
OF HOME COMPUTING!"
```

You already know what this line does.

```
12 LET A=1+A
```

This step seems to contradict itself. For example, if $A = 5$, then how can $5 = 1 + 5$? Actually, this step isn't contradictory. Remember that LET assigns a number to a memory location, and in this case the location is designated A. Therefore, LET $A = 1 + A$ just means that the number stored in A should be changed to the number now in A (which is 0) plus 1.

```
13 IF A=3 THEN 20
```

Here's the IF...THEN statement that tells the computer how many times to run the program. Simply put, IF asks the question: "Is the number stored in memory location A a 3?" IF the answer is yes, THEN line 13 transfers program execution to line 20, which ends the program. Otherwise, the program continues to line 15, which it does because A only equals 1 at this point.

```
15 GOTO 10
```

This statement tells the program to return to line 10. The computer then flashes the message in line 10, advances to line 12, and adds another 1 to memory location A, which is now $0 + 1 + 1$ or 2. It then continues to line 13, where it checks to see if the number in A is 3. It's not ($A = 2$), so the computer arrives at line 15, and the process continues. But the next time through the loop, the number in A reaches 3—every time the computer follows the loop, it adds another 1 to A. The third time through the loop, A will be $0 + 1 + 1 + 1$, or 3. So, since A is now 3, the IF of line 13 is fulfilled, and the THEN transfers program control to line 20.

```
20 END
```

The computer comes to a stop and flashes a READY after the three WELCOME messages.

Now do you understand how the expanded

program works? If so, how would you order the computer to print ten WELCOME messages instead of three?

Well, if you changed line 13 to read IF A=10 THEN 20, you're absolutely correct. And you're well on your way to understanding how the IF...THEN statement allows programs to establish various kinds of loops.

Incidentally, the A (IF A=?) is called a *variable* by computer programmers. That's because the number assigned to A can vary; it can be any number you select.

Loops can be very simple, like the one we've just studied. Or they can be more sophisticated, like this one. This loop orders the computer to display a screenful of random numbers:

```
5 CLS
6 LET Z=0
10 PRINT RND(8); " ";
15 LET Z=Z+1
16 IF Z=240 THEN 30
20 GOTO 10
30 GOTO 30
```

When this program was run on a real computer, the following pattern of random numbers was flashed on the screen:

```
1 4 3 1 8 3 2 7 8 8 5 1 3 1 8 8
6 3 8 2 8 6 3 3 3 4 7 6 6 3 8 2
4 5 2 1 5 7 5 4 4 1 3 7 4 3 3 8
4 4 2 6 1 4 7 1 8 5 4 4 2 3 5 7
5 5 2 8 5 6 7 8 1 8 7 1 5 5 6 3
3 8 6 1 7 7 1 4 5 4 5 8 5 2 6 6
1 5 6 3 3 4 7 6 3 5 6 4 2 5 1 2
8 7 2 7 4 3 2 5 7 2 7 1 1 4 3 4
7 4 3 1 2 5 8 6 3 1 5 6 6 6 5 8
3 1 1 6 4 4 4 6 6 5 8 4 2 4 6 1
7 2 7 8 5 5 1 4 6 2 8 4 3 3 3 6
3 7 1 5 8 5 7 8 8 6 3 6 1 7 7 7
6 6 6 4 6 7 3 8 4 1 4 5 5 1 3 6
6 6 6 1 5 1 3 6 4 5 6 5 1 8 7 7
5 1 5 5 1 7 8 4 4 5 7 7 5 3 7 2
```

This program introduces a couple of new BASIC terms, so let's see how it works.

```
5 CLS
```

CLS means "clear screen"—it removes everything already on the screen so that the full screen is available for your text. In this case, CLS isn't absolutely necessary because the extraneous material will be automatically removed from the screen as the lines of numbers are flashed on the screen. Its use here simply makes for a neater presentation of the random numbers.

```
6 LET Z=0
```

This assigns a value of 0 to memory location Z.

```
10 PRINT RND(8); " ";
```

RND is short for "random number." RND (8) converts the computer into an electronic "die" that automatically generates random numbers between 1 and 8, just as if a die were thrown on a table in a board game. Any number can be inserted inside the parentheses. For example, RND (100) would generate random numbers between 1 and 100.

PRINT tells the computer to display the selected random number on the screen. The remainder of the line (;" "); tells the computer to "print" a single blank space after the selected random number; this separates the numbers.

The semicolons tell the computer to print the numbers on the same line; when a line is full of numbers, the computer automatically proceeds to the next line. Without ;" "; the screen would display random numbers in a single column along the left side of the screen.

```
15 Z=Z+1
16 IF Z=240 THEN 30
20 GOTO 10
```

These lines establish a loop that orders the computer to generate 240 random numbers. That's equivalent to 15 lines on the screen, containing 16 numbers each. When all 240 numbers are on the screen, the IF...THEN orders the program to move to line 30.

```
30 GOTO 30
```

This line is a "do-nothing" step. It tells the computer to establish a loop that seemingly does absolutely nothing! Actually, this step can serve a useful purpose in some cases. If line 30 were

an END statement, the computer would stop running the program. A line like 30 GOTO 30 is useful, for instance, when you want the computer to freeze a video display that would be altered if the program stopped running.

There's one catch about using a step like 30 GOTO 30. To enter new information, the computer's BREAK key must be pressed, because once the screen is full of random numbers the program will continue endlessly at line 30. BREAK is needed to tell it to stop.

Using FOR...NEXT to Establish Loops

How would you like to take the program that fills the computer screen with random numbers and reduce it from seven to only five steps? A new BASIC expression called FOR...NEXT lets you do just that. Here's what the new program looks like compared to the original:

New Program (FOR...NEXT)

```
5 CLS
7 FOR Z=1 TO 240
10 PRINT RND(8); " ";
15 NEXT Z
30 GOTO 30
```

Old Program (IF...THEN)

```
5 CLS
6 LET Z=0
10 PRINT RND(8); " ";
15 LET Z=Z+1
16 IF Z=240 THEN 30
20 GOTO 10
30 GOTO 30
```

Both programs do exactly the same thing—fill the screen with 240 random numbers. Compare the two programs, however, and you'll see that the new program omits the four lines (lines 6, 15, 16, and 20) originally used to set up the loop that tells the computer to generate and print the random numbers.

The new program replaces the four lines associated with the IF...THEN expression of the original program with only two FOR...NEXT lines. Here's how the new program works:

```
5 CLS
7 FOR Z=1 TO 240
```

Line 5 clears the screen, and line 7 stores a 1 in a memory location designated Z.

```
10 PRINT RND(8); " ";
15 NEXT Z
30 GOTO 30
```

Line 10 selects and prints a random number. Line 15 then orders a 1 to be added to the number in memory location Z. The cycle continues over and over again. After 240 random numbers have been displayed on the screen, line 15 is no longer valid, so the computer advances to the next line, which is 30.

As you can see, FOR...NEXT can be much more efficient than IF...THEN. But IF...THEN is still very useful, particularly because the variable can be a number in any designated memory location; for example, IF A=B THEN 100. This can let you do some very clever programming tricks.

A useful application for FOR...NEXT is as a so-called *timer*. The random number programs we've been tinkering with are very fast. For example, the second one can fill the screen of a computer with 240 numbers in about six seconds! Suppose you want to slow down the computer a bit—in fact quite a bit, so that it flashes a new random number every second or so. The FOR...NEXT timer is the way to do this. Here's what the timer looks like:

```
12 FOR B=1 TO 475
13 NEXT B
```

As you can see by the line numbers, the timer fits neatly between lines 10 and 15 of the short version of our random number program. How does it work? Simple! When the computer reaches line 12, it places a 1 in a memory location called B. Line 13 then instructs the computer to return to line 12 and place a 2 in B. The process continues, all the while using up time, until the number in B is 475. The program then continues to the next random number selection. Result? The random numbers appear on the screen at about one-second intervals, thanks to the delay caused by the FOR...NEXT timer.

Another use for FOR...NEXT is in various kinds of programs involving arithmetic. We'll look at several of these applications later, but first, let's examine another role of the computer.

CONVERSATIONAL PROGRAMMING

Few features of computers are as impressive as their ability to carry on a "conversation." Naturally, the computer's side of the conversation has to be programmed. But the result can greatly simplify the use of a computer, because its screen can display instructions for you.

A key BASIC statement for conversational programs is INPUT. This statement has the same effect as PRINT, and it allows the program to accept information from the keyboard. Here's a simple example of a program that uses INPUT:

```
10 INPUT "HOW MUCH DO YOU WEIGH  
IN POUNDS";P  
20 PRINT "YOUR METRIC WEIGHT IS ";  
P*.4534;" KILOGRAMS."  
30 END
```

When you run this program, line 10 flashes the question HOW MUCH DO YOU WEIGH IN POUNDS? on the computer's screen. A question mark isn't needed in the program, because INPUT automatically inserts it. The presence of the P after the semicolon tells the computer to stop and wait until someone enters a weight in pounds into the keyboard. After this keyboard entry is made, the weight in pounds is loaded into a memory location designated P. The computer then proceeds to line 20.

Line 20 tells the computer to display the words YOUR METRIC WEIGHT IS _____ KILOGRAMS. Everything inside quotation marks is automatically printed, and the semicolon tells the computer to print everything on the same line. P*.4534 introduces a couple of new ideas, however, so let's study them.

P is the label assigned to the memory location that stores your weight in pounds. The number .4534 is the conversion factor by which a weight expressed in pounds must be multiplied to get its metric equivalent in kilograms. And * is the BASIC symbol for multiplication. The usual multiplication sign $\times$ isn't used because it can be confused with the letter X.

Now that you've seen how the program works, let's run it on the computer. Assume that the program is entered and that you've typed RUN. The screen will display:

HOW MUCH DO YOU WEIGH IN POUNDS?

This means that the computer is ready to receive your weight, so type in whatever your weight happens to be—our example uses 158.

```
HOW MUCH DO YOU WEIGH IN  
POUNDS?158  
YOUR METRIC WEIGHT IS 71.6372  
KILOGRAMS.  
READY
```

Impressed? This may not be very exciting with an imaginary computer, but it's very effective when tried on an actual computer.

Here's another example of a program that uses INPUT to ask a question and PRINT to deliver a response:

```
10 INPUT "HOW MUCH MONEY DID YOU  
EARN LAST YEAR";M  
20 PRINT "UNLESS YOU RECEIVE A  
SUBSTANTIAL"  
30 PRINT "RAISE, YOU WILL HAVE TO  
WORK"  
40 PRINT 10000000000/M;" YEARS  
TO EARN A"  
50 PRINT "BILLION DOLLARS!"  
60 END
```

You should have no trouble understanding how this program works, because we've introduced only two new BASIC rules. The first is that a long line of text can be split into a series of PRINT statements. The second is that BASIC uses the slash symbol to indicate division. Assuming your income last year was \$15,000, here's what the screen will display after the program has been entered and run. You don't have to type in the dollar sign, because only the number of dollars—15,000—matters in this program. On a real computer, you should not type a comma as a place marker in a long number, so you would type in 15000.

```
HOW MUCH MONEY DID YOU EARN LAST  
YEAR?15000  
UNLESS YOU RECEIVE A SUBSTANTIAL  
RAISE, YOU WILL HAVE TO WORK  
66666.7 YEARS TO EARN A  
BILLION DOLLARS!  
READY
```

Some conversational programs are amazingly complex and can carry on almost humanlike

conversations. Many home computer enthusiasts enjoy developing such programs, just for the fun of showing people how smart their computers are.

An important BASIC operation that makes more advanced conversational programs possible is known as the *string function*. A string is simply a group of characters or symbols. It can be a sentence such as HOW ARE YOU?, a name, an address, a telephone number, or a list of characters such as 8P74S;+G.

A string is designated by the \$ sign and is assigned to a memory location indicated by a letter of the alphabet. The number of strings you can use, and the number of characters in each string, depend on the type of computer you own. Some computers can accept only a couple of strings—A\$ and B\$, for instance—limited to a maximum number of characters. Other computers can assign a string function to any character of the alphabet and can handle much longer strings.

The string function is very important in word processing, a computer application that is becoming increasingly popular.

PROGRAMMING FOR WORD PROCESSING

Word processing, either with special software for a home computer or with a business machine that doesn't do anything but word processing, lets writers type their material directly into a computer. Mistakes can be corrected and revisions can be made much faster with word processing than with pencil and paper. And the final text can be stored on magnetic tape or disks that can be read by a computer and fed to a printer.

One very common use for word processing is generating "personalized" form letters. Here's a program for a form letter that a legislator's secretary can use to speed up answers to mail from constituents:

```
5 CLS
10 INPUT "WHAT IS THE VOTER'S
TITLE AND LAST NAME";A$
20 INPUT "WHAT IS THE VOTER'S
FIRST NAME ONLY";B$
30 PRINT
```

```
40 PRINT
50 PRINT "DEAR ";A$;" ":"
60 PRINT
70 PRINT "THANK YOU FOR YOUR
LETTER, ";B$","
80 PRINT "I'M ALWAYS GLAD TO
HEAR FROM"
85 PRINT "VOTERS LIKE YOU. BE
ASSURED I'LL"
90 PRINT "TAKE YOUR VIEWS INTO
ACCOUNT."
100 PRINT
110 PRINT "                REGARDS,"
120 PRINT
130 PRINT "                W.E.TAXMORE"
140 PRINT
150 PRINT
160 PRINT "IF YOU WANT TO
PREPARE ANOTHER LETTER, TYPE
RUN."
```

As you can see, this program is little more than a series of PRINT statements preceded by a couple of INPUT statements that assign the voter's full name and first name to two strings. Notice the space after "DEAR" in line 50? A space is needed here (and after LETTER in line 70) because strings are often placed directly adjacent to any text that's to be printed. The space inside the quotation marks makes certain that the letter's salutation will read "DEAR VOTER" and not "DEARVOTER."

Look at the PRINT statements in lines 30, 40, 60, 100, 120, 140, and 150. These lines print nothing on the screen. They simply provide blank lines in the final text. And the PRINT statements in lines 110 and 130 specify that REGARDS and the legislator's name will appear at the right side of the letter, because space has been left after the first quotation marks and before the REGARDS and the name. Otherwise, REGARDS and the name would simply start at the beginning of those lines.

Here's how the program is used to respond to Mr. Fed-up Taxpayer. First, the program asks for the constituent's name:

```
WHAT IS THE VOTER'S TITLE AND
LAST NAME?MR.TAXPAYER
WHAT IS THE VOTER'S FIRST NAME
ONLY?FED-UP
```

After the first name is entered, the screen displays the text of the personalized letter:

DEAR MR. TAXPAYER:

THANK YOU FOR YOUR LETTER, FED-UP.
I'M ALWAYS GLAD TO HEAR FROM
VOTERS LIKE YOU. BE ASSURED I'LL
TAKE YOUR VIEWS INTO ACCOUNT,

REGARDS,

W. E. TAXMORE

IF YOU WANT TO PREPARE ANOTHER
LETTER, TYPE RUN,
READY
■

Of course, a printer is necessary to make full use of a computer's word processing capabilities. (Printers are discussed in Chapter 4, "Peripherals.") But think of all the applications you could find for a word processing computer—personalized correspondence, mailing lists, record keeping, and much more.

USING A COMPUTER AS A CALCULATOR

Now that we've seen how computers can be used for many jobs that have nothing to do with arithmetic, let's look at some of the more traditional roles they're used for.

A useful feature of the BASIC language used by many home computers is the so-called "calculator mode." You can try this mode out with your real or imaginary computer. Type:

```
PRINT 4+5
```

Then press ENTER. The screen instantly responds with:

```
9
```

The computer can also subtract (-), multiply (*), and divide (/). For example:

```
PRINT 3*4*5*6
```

Then press ENTER. The screen will flash:

```
360
```

Here's another example. Type:

```
PRINT 123456/654321
```

Then press ENTER. The screen responds with:

```
.188678
```

Of course, you can easily perform all these operations with a pocket calculator. The computer begins to outperform a calculator only when it's used in its programming mode.

All of the BASIC operations we've already learned about, and several others, can be applied to programs involving numbers. Two new BASIC functions you should know about are READ and DATA, which are often used in arithmetic applications. Let's see how they work.

Using READ and DATA in Arithmetic Programs

READ is simple—it commands the computer to read the number in one or more designated memory locations. The numbers in the locations are supplied by DATA. Confused? Here's a simple program that shows how READ and DATA are used:

```
10 READ A, B
20 LET Q=A+B
30 LET S=A-B
40 PRINT Q/S
50 DATA 14, 63
60 END
```

After this program is entered and run, the screen of the computer will immediately display:

```
-1.57143
```

Do you understand how the program arrived at this value? Let's review the program a step at a time to make sure.

```
10 READ A, B
```

This READ statement tells the program to read the data stored in memory locations A and B in preparation for the next two steps.

```
20 LET Q=A+B
```

This step establishes a memory location identified as Q and loads it with the sum of the numbers in locations A and B.

```
30 LET S=A-B
```

Another memory location, S, is established and loaded with the difference between the numbers A and B.

```
40 PRINT Q/S
```

This operation wraps up the program by dividing the number in Q by the number in S and flashing the result on the screen.

```
50 DATA 14,63
```

Here's the data that's loaded into those memory locations A and B, described in line 10. The first number (14) is loaded into the first memory location (A), and the second number (63) is loaded into the second memory location (B). So $A = 14$ and $B = 63$.

How does the computer get to the data in time to use it when it's given at the end of the program? Simple. A READ statement sends the computer off to read any DATA statements that are in the program, no matter where they're located. It's customary to place DATA statements at the beginning or end of a program, but they can be placed anywhere; the computer will automatically find them.

READ and DATA are very useful, particularly because they let you use many different pieces of DATA in a program. But there's another way to supply numbers to a computer, which we already learned about—INPUT.

Using INPUT in Arithmetic Problems

In the discussion about conversational programs, we learned how INPUT can be used by the computer to ask you the value of some variable, such as age or weight. INPUT can also be used to ask a series of questions, as in this revised version of the program that we looked at earlier:

```
10 INPUT "WHAT IS THE VALUE OF A";A
20 INPUT "WHAT IS THE VALUE OF B";B
```

```
30 LET Q=A+B
40 LET S=A-B
50 PRINT "A+B DIVIDED BY A-B IS ";
  Q/S
60 GOTO 10
70 END
```

As you can see, this program eliminates the READ and DATA statements, and lets the computer simply ask for the information it needs. After the computer displays the result, line 60 loops the program back to the first line, and the computer asks the first question again.

Using FOR...NEXT in Number Applications

So far we haven't asked our imaginary computer to solve problems any more complicated than those a pocket calculator can easily handle. The FOR...NEXT operation, however, lets us write programs that order the computer to rapidly solve a series of problems and present the results in neatly tabulated rows on its screen—something no calculator can do.

For instance, here's a simple program that squares the numbers from 1 through 10 and displays the results:

```
10 FOR N=1 TO 10
20 PRINT "THE SQUARE OF ";N;
  " IS ";N*N
30 NEXT N
40 END
```

Type RUN, press ENTER, and the screen will display:

```
THE SQUARE OF 1 IS 1
THE SQUARE OF 2 IS 4
THE SQUARE OF 3 IS 9
THE SQUARE OF 4 IS 16
THE SQUARE OF 5 IS 25
THE SQUARE OF 6 IS 36
THE SQUARE OF 7 IS 49
THE SQUARE OF 8 IS 64
THE SQUARE OF 9 IS 81
THE SQUARE OF 10 IS 100
```

Try that with a calculator! A calculator can easily square this sequence of numbers, of course, but it can't present the results in neatly tabulated form, complete with explanations. Only a computer can give you the answers like this.

Let's make the program fancier by having the computer display the numbers 1 through 10, their squares, their cubes, and their reciprocals (one divided by the number). Here's the new program.

```
10 PRINT "NUMBER", "SQUARE",  
"CUBE", "RECIPROCAL"  
20 FOR N=1 TO 10  
30 PRINT N, N*N, N*N*N, 1/N  
40 NEXT N  
50 END
```

The commas in line 10 establish four columns, complete with titles. Line 30 supplies the information for the four columns. Run this program and the screen will display:

NUMBER	SQUARE	CUBE	RECIPROCAL
1	1	1	1
2	4	8	.5
3	9	27	.333333
4	16	64	.25
5	25	125	.2
6	36	216	.166667
7	49	343	.142857
8	64	512	.125
9	81	729	.111111
10	100	1000	.1

This should impress the most ardent calculator user—and it's only a trivial example of what can be done with the help of FOR...NEXT and PRINT.

Let's look at another example of how FOR...NEXT can be used. The following program generates the complete multiplication table for the digits 1 through 10, in less than three seconds:

```
5 CLS  
10 PRINT "THE MULTIPLICATION  
TABLE"  
20 PRINT  
30 FOR X=1 TO 10  
40 PRINT X; " ";  
50 NEXT X  
60 PRINT  
70 FOR Y=2 TO 10  
80 FOR Q=1 TO 10  
90 PRINT Y*Q; " ";  
100 NEXT Q  
110 PRINT  
120 NEXT Y  
130 GOTO 130
```

If programming appeals to you, why not spend a few minutes figuring out how this program works, using what you've learned so far? Remember, though, you don't have to know how a program works to use it. Programming can be fun—but if you don't enjoy it, don't get discouraged about using a computer. There's plenty of ready-to-run software available that doesn't require any programming at all.

COMPUTERS AS TEACHERS

As you've seen, computers can solve various kinds of arithmetic problems. They can even be programmed to teach people how to solve arithmetic problems.

Here's a very simple BASIC program that converts our imaginary computer into an electronic multiplication teacher:

```
5 CLS  
10 LET R=RND(10)  
20 LET Q=RND(10)  
30 PRINT "WHAT IS ";R;" TIMES ";  
Q;"?"  
40 INPUT V  
50 LET S=R*Q  
60 IF S=V THEN 90  
70 PRINT "SORRY, PLEASE TRY  
AGAIN."  
80 GOTO 30  
90 PRINT "CONGRATULATIONS!  
THAT'S CORRECT."  
100 PRINT "TYPE RUN IF YOU WANT  
TO TRY ANOTHER PROBLEM."
```

Here's a sample run of this interesting program:

```
WHAT IS 7 TIMES 3?22  
SORRY, PLEASE TRY AGAIN.  
WHAT IS 7 TIMES 3?21  
CONGRATULATIONS! THAT'S CORRECT.  
TYPE RUN IF YOU WANT TO TRY  
ANOTHER PROBLEM.  
READY
```

Can you explain how the program works? Since you've already been introduced to all the BASIC statements used here, you should be able to figure it out. But again, it's not necessary to understand how the program works to use it. Even professional computer program-

mers often use programs developed by other people instead of writing their own.

A program like this can make learning the multiplication table fun. Teaching programs can be designed to present many different kinds of arithmetic problems. They can also be designed to teach facts—history, grammar, dates—and even foreign languages.

LEARNING MORE ABOUT PROGRAMMING

In this chapter, we've introduced many of the statements used for programming in BASIC. There are many other BASIC statements and operations, too, and you'll want to learn how they're used if you're interested in learning more about programming.

One area you'll want to cover is BASIC shortcuts. These are the tricks and abbreviations you can use to condense programs. Another is the

use of subroutines—programs within a program—that are referred to over and over as the main program is being run by the computer.

You can find out more about BASIC from the dozens of books that have been published about this easy computer language. Because there are many dialects or versions of BASIC, it's important to look for books written for the version of BASIC used by the computer you'll be using.

You can learn the fundamentals of BASIC even if you don't have a home computer. For real hands-on experience, try visiting a computer store. Many stores will be happy to let you use a computer to try out some of the things you've learned here. The members of a computer club are a good bet for giving you a trial session, too. Even if you don't think programming is for you, a brief session at the keyboard may surprise you. Give it a try. You'll discover that BASIC is very easy to learn.

The Vocabulary of BASIC

BASIC (Beginner's All-purpose Symbolic Instruction Code) is a high-level programming language used by most personal computers. There are more than 400 BASIC terms, commands, instructions, and symbols used by the 250 or so different kinds and models of computers that understand the BASIC computer language. No single computer understands every BASIC instruction, because there are different dialects of this computer language. But most computers understand a few dozen of the most important ones. Here are some BASIC commands.

AUTO—A timesaver instruction that tells your computer to automatically assign a number for each line in your program; for example: 20 PRINT "BASIC IS A COMPUTER LANGUAGE."

BREAK—Allows you to interrupt a program that your computer is in the process of running. See CONT.

CLOAD—Used by some computers to load a program from a cassette tape into the computer's internal memory. See CSAVE.

CLS—Clear screen; a fast way to clear or erase

everything from the computer's video screen. Very handy for removing the text that can quickly fill up the screen of a video display.

CONT—Short for "continue." This command tells your computer to continue running the program you stopped by ordering a BREAK.

CSAVE—Used by some computers to load information or programs from the computer's internal memory onto a cassette tape. See CLOAD.

DATA—A statement that provides a handy place to put numbers or information intended for later readout by a READ command. The information should be separated by commas; for example, DATA 14, 27, 46. See READ.

DRAW—Used by some computers to permit a line to be drawn on a video screen. A similar command is called PLOT. Different computers require various information about the starting and ending points of the line to be drawn.

END—Placed at the end of a program, this is an instruction to your computer to stop and await further instructions. END isn't always needed, but it can prevent the computer from

looking for something else to do because it hasn't been told to stop.

FOR...NEXT—A powerful statement that allows you to cycle or loop through a section of your program as many times as you specify. For example:

```
10 FOR X=1 TO 10
20 PRINT X*X
30 NEXT X
```

This simple example tells your computer to print out the square of each number from 1 through 10 on its screen.

IF...THEN—A conditional statement that tells your computer to jump ahead to another part of the program if a specific condition is met. For example:

```
IF X=10 THEN 50
```

This instruction tells your computer to go to line 50 in your program if X—maybe the result of a previous operation—equals 10. Otherwise, the program will simply go on to the next line in the program.

INPUT—Tells your computer that it needs information from you, letting you respond to a programmed question. It can often be used in a program in place of PRINT, as in:

```
10 INPUT "HOW OLD ARE YOU";X
20 PRINT "YOU ARE ";X
30 END
```

When you run this simple program, the computer will display on its screen HOW OLD ARE YOU?, even inserting the question mark. When

you type in your age, the computer automatically assigns it to a special memory location labeled X. Then the computer will display YOU ARE, followed by whatever is in memory location X, in this case your age.

LET—In some older versions of BASIC, used to assign a value to a character or symbol, as in: LET Z = 100. LET is often optional, so the statement can be shortened to simply Z = 100.

LIST—Entered from your keyboard, it tells the computer to display your program on its video screen.

PRINT—A command with many uses. PRINT can be used directly from your keyboard, as in: PRINT 1345 + 2078. The video screen will display 3423. PRINT can also be used as a statement in a program to print on the screen anything between quotation marks.

READ—Used with DATA, allows your program to assign information or numbers to their proper place.

REM—Short for "remark." Lets you identify lines and subroutines in your programs with helpful remarks about their purpose and operation. REM statements take up valuable memory space, but they can save lots of frustration long after you've forgotten how to use a program you've saved.

RUN—The go-ahead signal. When you type this into your keyboard, your computer will begin processing or running your program.

TAB—Similar to the tab key on a typewriter; used with PRINT statements to determine where information is to be printed on a line.

THE FUTURE: WHAT'S AHEAD IN COMPUTERS?



This has been an amazing century. In just a little more than 80 years, we have progressed from steam-powered trains to space shuttles, from gaslit homes to advanced electronics. We send astronauts into orbit around the earth and bring them back again. We are accustomed to computerized marvels that would have startled our great-grandparents. From solar-powered calculators to wristwatch television sets and video games, we are surrounded by the products of the computer revolution.

Amazing as these developments have been, there are even more exciting innovations on the horizon. Technology is not standing still; it's moving ahead with a speed that would dizzy Henry Ford. The home computer is certainly the most important consumer product since the television, and it is likely to affect our society as much as the automobile has. But it is only a prelude of what is to come.

CHARTING THE CHANGES

Predicting the future is not the easiest of occupations. One thing of which we can be fairly certain, however, is that whatever happens in the twenty-first century, the computer will be a large part of it. The computer revolution is more than just a catch phrase; it is a technological and social upheaval whose impact will be as great as that of the Industrial Revolution in the nineteenth century. The Industrial Revolution completely changed concepts about how work was done; machinery replaced human muscle and manually operated tools to become the productive force in society. A computer is also a tool, but it is not just any ordinary tool; it is something completely new. Computers are tools that not only perform feats human beings are not capable of, such as making numeric calculations of dizzying speed and complexity. They can also—in as yet primitive ways and always under human control—simulate some aspects of human thought processes. Wherever you live, whatever you do, computers are changing your life.

The Invisible Computer

Even if you never own nor even use a computer, these “machines that think” are becoming a bigger and bigger part of your life. Microprocessors have found their way into

such common items as microwave ovens, car engines, vending machines, and just about any electronic device. Most of these “invisible computers” operate entirely on their own; you may never even know they are there. They are programmed to perform some simple, repetitive functions and continue to do so until unplugged or reprogrammed.

What do these microprocessors do? Besides making appliances easier to use—push a few buttons on a microwave oven to automatically defrost and cook a meal—they can also be programmed to save energy. Microprocessor-controlled appliances can carefully monitor and control the amount of electricity consumed in their operation.

A key application for the future is the microprocessor-controlled car. Already silicon chips are used extensively to control emissions and save fuel. They help mechanics diagnose problems and are being used experimentally to help a driver know the car's position or location on the road. Microprocessors are used in seats that “remember” your favorite positions for in-town driving and for country cruising. Computer-controlled display panels provide information on every part of a car's operation, and soon these displays will assist you in trip planning by showing various optional routes. Microprocessors may even have a role to play in safety; some carmakers are experimenting with computer-controlled braking. And these are only a few of the possibilities.

These are not the cars of the 1990s; they are the cars of today. What tomorrow will bring—perhaps a computer controlling the car from start to stop, linked to invisible data networks—is still in the realm of conjecture and experimentation. However, you can be sure the cars of the future will contain more microprocessors.

The Shrinking Computer

One of the most exciting developments today is the pocket or handheld computer. As we described in earlier chapters, these devices are not just glorified calculators; they can perform many of the same functions their full-sized counterparts can. The power that once existed only in room-sized machines is now packed into smaller and smaller computers.

Computers are beginning to shrink in another way, too: peripherals that are now plugged into a computer to expand its abilities may eventually be absorbed into the computer console itself. This is already happening with pocket and portable computers. Modems and printers, among the most popular accessories, may soon become standard parts of all personal computers. For example, the Radio Shack Model 100 includes a built-in modem and the software needed to run it.

The Affordable Computer

Some people want to own a home computer, but remembering how fast the price of calculators dropped, they wonder if they should wait a while for computer prices to fall even more. Our advice, however, is not to wait. Today's \$200 or \$300 home computer does give you the power that would have cost tens of thousands of dollars a decade ago, but there is very little chance that computers will become as inexpensive as pocket calculators. Prices for home computers may not fall much more than they already have.

The reason is simple: calculators have very few moving parts, and the price they sell for now is little more than the cost of those parts and the labor to assemble them. Home computers, on the other hand, have quite a few moving parts. The cost of these parts, plus labor and distribution—getting them to your dealer's shelves—is presently close to the price they sell for. The low end of the price range will probably stay in the \$50 to \$75 range for the foreseeable future.

Prices of computer accessories, however, are still declining, especially for printers and disk drives. But these prices too are leveling off. Most of these accessories have many moving parts, and there is a lot of labor involved in assembling them. A more likely development than further price cuts is that more of these peripherals will be built into future home systems, which may even somewhat raise the price of the packages needed to start computing.

The biggest cost reductions will probably come in larger computers and peripherals designed primarily for professional and business users. Home computers will likely stay in about the same price range for some time to come.

THE FRIENDLY COMPUTER

If you have been reading and talking about computers a lot recently, you have probably heard the term *user friendly*. It is one of the industry's hottest current catchwords. The term is used to describe machines (and software) that don't require you to know much about computers. In plain English, *user friendly* simply means "easy to use." Home computers are getting easier to use, but you still have to know which words and letters to type into a keyboard to get the computer to do what you want. And before you can use today's hardware or software, you still must read the manual and spend some time learning to follow its instructions.

The computer industry realizes that the less complicated computers are to use, the more people will buy them. Manufacturers are already taking giant steps in this direction. Keys on some machines are labeled in plain English. Such commands as COPY, FILE, and MAIL are accomplished with one keystroke. More and more software programs lead you step-by-step through everything you need to know in order to use them. No more long, boring, incomprehensible manuals; most instructions can simply be displayed on the screen in front of you. This means that soon almost everyone will be able to sit down at a computer and use it immediately, even if they have never used a computer before.

Computers That Talk—And Listen

In the popular television show "Star Trek," every time Mr. Spock asked the computer for information, it replied, "Working." As a result of research in the past few years, the talking computer is no longer as farfetched as it once seemed. Someday, perhaps in the not-too-distant future, you may be able to sit down at your computer and give it a spoken command like, "Today's bank balance, please." And the computer will whirl quietly, respond with the figure, and give you a printout of recent transactions as well.

This type of back-and-forth dialogue with a computer depends on two separate skills: the computer's ability to speak and its ability to understand human speech. As we mentioned, getting the computer to understand is harder.

Voice Recognition. Getting a computer to understand spoken words is very difficult. No two people sound alike nor even pronounce the same words in exactly the same way. (Think of the difference between New England and New Orleans natives!) Some voices are high pitched, others are low. Some say the same thing in different ways—for example, “Park the car,” or “Move the automobile into the marked space.” Because a computer cannot follow instructions unless every task is broken down into its simplest steps, too much information—or information expressed in the wrong way—can overwhelm a computer.

The first step, then, in getting a computer to understand voices is converting the sounds into the binary 1s and 0s the computer understands. This is relatively easy through the use of special circuits called A/D (analog/digital) converters, or ADCs. These convert the continuous (analog) tones of spoken language into binary (digital) signals. After this, the difficulty begins. Research is heading in two directions—getting the computer to analyze word meanings and getting it to analyze actual sounds. But neither is an easy task, and computers will need huge memories to understand more than just a few words.

Some plug-in cartridges with microphones are available for hobbyists who want to experiment with voice recognition, but these are very primitive devices, which have to be programmed specifically for one voice. They can understand only a relatively few words. Although this field of interest is one of the hottest in computer science today, it will probably be a good decade or more before there are computers that will understand a large number of spoken instructions.

Voice Synthesis. If we are going to hold conversations with a computer, it must not only understand what is being said, but it must also be able to respond. This is called *voice synthesis*. Although making a computer talk is not as complex as making the computer understand what it hears, it is no simple task.

A synthesized voice isn't merely a tape recording of someone's voice played back by the computer. Instead, voice synthesizers work by analyzing input signals—the bar code readers in the grocery store, for instance—and breaking them down into the more than 100 differ-

ent phonemes or sounds of which spoken English is composed. After the phonemes are entered, the computer analyzes them and generates a signal for each one. These signals are fed to electronic circuitry and eventually to the computer's speaker.

The results, even at present, are sounds that only slightly resemble a human voice. Today's voice synthesizers produce the metallic tones of robots in early science-fiction movies—little expression, just a flat, monotone sound. Some are hard to understand unless you listen closely. More human-sounding voice synthesizers will be developed over the next few years, and they may well be built into many home computers. These devices won't do away with screens and printers, because it will still be easier to read a list than to remember the same list spoken aloud.

If you are interested in experimenting with voice synthesis now, you can. There are various voice synthesizers available that plug into most home computers. These peripherals cost from \$200 to \$400, and their sound is far from natural. However, they are fun to use, and they will give you a notion of what is to come. In fact, even now there are some computer games being written to work with voice synthesizers.

Programming for Everyone

Programming requires learning a language such as BASIC and breaking the task to be done into individual steps. Recently, this process has become increasingly simple, a trend that is likely to continue. Remember our discussion of machine language and assembly language in Chapter 3. There, we briefly traced the development of programming languages from binary codes to BASIC, and each step took us closer to English-like commands.

If, for example, you wanted to print the square root of all numbers from 1 to 100, and wrote a program to do this in BASIC, it might look like this:

```
10 CLS
20 FOR X=1 TO 100
30 PRINT SQR(X)
40 NEXT X
50 END
```

Although this is a very simple program, it points out the number of steps needed to accomplish the task. Wouldn't it be easier if you could simply type this?

```
PRINT THE SQUARE ROOT OF ALL  
NUMBERS FROM 1 TO 100.
```

Computer scientists are working to create languages that are this simple to use. Some similar languages already exist, but they are experimental and are not generally available for home computers. These *conversational programming languages* should be developed within the next five years, and they probably won't be any more expensive than BASIC. And like BASIC, they may come as standard equipment with home computers.

THE CHANGING TECHNOLOGY

Computers are becoming more and more friendly, and there are many reasons for this. As we've stressed throughout this book, the technology is changing fast. Both hardware and software have come a long way since the early days of computers, and you should be aware of what's in store for the future. Developments in hardware and software during the next 10 years may have a profound effect on you and your lifestyle.

Advanced Microprocessors: Increasing Computing Power

As more circuits are packed onto silicon chips, microprocessors—the brains of personal computers—will become more powerful. The 16-bit revolution is becoming today's status quo, and even more powerful microprocessor chips are on the way. Major manufacturers have built experimental microprocessors that handle data in 32-bit and even 64-bit chunks. In fact, there are now microcomputers on the market that use some of the first of these 32-bit microprocessors. As they become more available over the next few years, these microprocessors will have all the power of the million-dollar computers now used by banks and large corporations.

The first of these microprocessors on the market will be far from inexpensive and will need more powerful peripherals. However, their

price will eventually fall enough to bring big computer power to everyone.

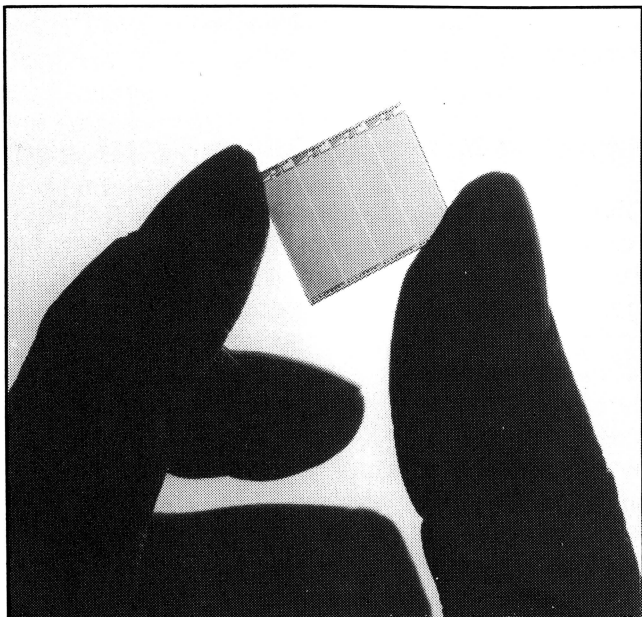
Advanced Memory: A Billion Bytes?

One of the keys to making a computer more powerful is adding memory. The more memory there is, the more the computer can do. While most of today's 8-bit home computers are limited to 64K of RAM, the new generation of 16-bit machines rapidly coming to market can handle a great deal more. A 16-bit machine can handle up to 10,000K (more than 10 million bytes) of RAM, although most manufacturers limit this to a more realistic 512K. There are few programs today that require that much RAM, although there are likely to be more in the near future. The integrated software systems require hundreds of thousands of bytes of RAM, and we are likely to see more integrated systems on the market.

Although RAM can be thought of as the working memory the computer uses when it's running a program, the mass storage area—floppy disks, for instance—is even more important. A computer system must have some permanent means of storing data when the power is turned off. Remember that RAM is volatile; information in RAM disappears when the power is off. There are a few important developments in mass storage going on right now.

Bubble Memory. Developed more than 10 years ago, bubble memory is capable of holding huge amounts of information in a small space. It is called bubble memory because the data is stored in microscopic magnetic bubbles. At first, this was too expensive to be practical for home computer use, but its price is coming down enough to be used in some home systems. In fact, there are a few firms now using bubble memory in the form of small plug-in devices. These small packages will hold even the largest programs in an easily portable form.

Bubble memory cartridges have one disadvantage. Although they are faster than cassette tapes, they are slower than floppy disks. However, recent developments with bubble memory storage techniques are rapidly changing this situation. Because it is experimental, bubble memory still does not have the random-access capability of a floppy disk, in which the drive's head goes directly to the data it needs. Despite



Bubble memory devices can store huge amounts of data in their microscopic magnetic bubbles.

the drawback, the attraction of bubble memory's storage capability means that it will be used in more computers in the future.

Optical Disks. Another form of storage that holds promise is a more sophisticated version of the laser-optical videodisk used to record movies and other video entertainment. Some companies are developing special versions of the videodisk to use with computers. These new disks use microscopic light and dark areas—rather than magnetic areas—to record the 1s and 0s of binary code. The information is read by a light beam rather than by a read/write head. Nothing physically touches the disk, and theoretically at least, it will never wear out.

Perhaps the biggest advantage of video data storage is the huge amount of information that can be held on a single disk. A computer videodisk can hold billions of bytes of data. To put that into perspective, the entire *Encyclopaedia Britannica* could be stored on a single disk! At the moment, a key disadvantage to this type of disk is that it is not reusable. Since you cannot erase information on them, a computer is able to store information on them only once. This means that floppy disks are still needed for programs that require swapping information from computer to disk and back again. However, with these disks, you will be able to store an entire library on a bookshelf.

In two to five years, perhaps sooner, this limitation could be eliminated. Research is now underway that will give videodisks reusable read and write capability. One Japanese firm has just developed a rather expensive machine—priced at about \$50,000, or so—that will erase and rewrite optical disks. If trends continue as they have in the computer industry, it won't be too long before this technology is adapted for small computers, as the price of this recording technique and its components drops.

Optical disks and disk players designed specifically for personal computers should start appearing within the next few years. It is still too early to say how much they will cost, but the players should sell for less than \$500 and the disks for about \$20 to \$30 apiece.

LOOKING AHEAD WITH HOME COMPUTERS

Although we have described how computer hardware and software are changing, as well as how new technology is changing the forms and expanding the uses of computers, we haven't much mentioned how these computers will affect daily life.

One of these changes is already apparent. Computer-controlled information networks are now accessible to everyone with a computer and a modem. But, there are more far-reaching changes that are bound to happen as the computer age develops. The applications listed here are just a few of the possibilities.

Networks: The Computer Connection

Information databanks, which provide the home computer user with data by linkage to a larger computer via phone lines, will become increasingly important and accessible. Already services such as The Source, CompuServe, and Dow Jones News/Retrieval Service are providing various kinds of data to thousands of home computer owners. To tie into these services, all you need is a computer, a modem, and a phone line. At the moment, you can get immediate information on everything from airline flight schedules to stock quotations to the news.

Nationwide telephone networks for home computers hold great promise for the "wired soci-

ety.” Exchanging electronic mail, messages, and programs with computer owners around the country is becoming commonplace. Some information services already act as electronic mailboxes—it’s as easy as placing a phone call—and these services have the wide reach of a newspaper.

The telephone-computer connection will profoundly change the way we live. Already, some people are working at home on computer terminals, rather than commuting to work every day. “Telecommuting” has the potential for vast savings in energy and building costs. It may also have an added bonus of keeping families closer together by cutting down commuting time. It is possible that telecommuting may become a commonplace by the 1990s.

Artificial Intelligence?

Will computers ever think? This question continues to be the subject of lively scientific debate and substantial research, as well as a public concern. At the moment, the Japanese are devoting large-scale resources to developing a “fifth-generation” computer that will “think.” Recent developments in the American computer industry indicate that we will be putting more emphasis on this here, as well.

The area of debate and research aimed at making computers “smarter” is called *artificial intelligence*. Research into it has been going on for years, and some of the findings have already resulted in easier-to-operate machines and easier-to-use programming languages.

A computer with true artificial intelligence would be able to “learn”—to take information given to it and make a decision based on experience or prior information. Computers with at least a partial ability to learn will probably exist by the late 1990s. They will most likely be tied into a nationwide computer network, so that one computer will be able to ask another about a subject the first has no information on, just as one person now trades knowledge of banking with another’s talent for carpentry.

Although such computers will *seem* to think, a true thinking machine with a will of its own is probably at least 50 years away—if one can ever be built at all. To build a machine that works like a human brain, we first have to understand how the brain works, and we are a long way from acquiring this knowledge.

Forging Ahead

We have seen that home computers are powerful, extremely capable machines. They have so many talents and capabilities that we have only just begun to discover their possibilities. By the end of this decade, it is likely that the home computer will be part of a home entertainment/control center. Your home computer may be hooked to a nationwide telephone network, to various disks, to your TV, and perhaps to a video cassette recorder. You may even have a small satellite disk on your roof or outside your window for receiving information from orbiting satellites.

But there’s more. Instead of mostly playing games and handling basic household financial and record-keeping chores, your computer will probably be hooked up to a climate-control and household-security system that will automatically turn the thermostat up and down, tell you how much electricity you need, turn your lights on and off, and keep the house secure while you are away. Many of these functions, in fact, are available in one form or another today. In the future, though, it is very possible that you will even be able to call your computer and ask if everything is all right at home.

And these developments aren’t very far away. These applications are not just science fiction because the technology to do them exists now. We’re only waiting for someone to put it all together, and you can bet it won’t be long. The home computer age is no longer a future possibility. It’s already here. The earlier you learn to adapt to and take advantage of computers, the more control you will have over their affect on your life. And you will have a lot of fun with them along the way.

BIBLIOGRAPHY:

SELECTED PERIODICALS

Apple Orchard

Published monthly by Orchard Potentials, 908 George St., Santa Clara, CA 95050; single issue, \$3.25; annual subscription, \$24.

Apple Orchard, aimed at owners of Apple computers, isn't published by Apple Computer Inc. but by a federation of Apple computer users' groups. A typical issue (about 110 pages) contains articles about peripherals designed for Apple computers, programs, programming languages, and the operation of the computer. There's also an extensive section devoted to new hardware and software products available for the Apple computers. Some of the articles may be too technical for beginners, but there's something here for every Apple owner.

BYTE

Published monthly by BYTE/McGraw-Hill, P.O. Box 590, Martinsville, NJ 08836; single issue, \$3.50; annual subscription, \$21.

BYTE, the first magazine for computer hobbyists, has expanded from about 100 pages a few years ago to more than 500 pages each issue. Because it carries technical articles about both hardware and software, it's mostly for advanced computer users. It also has frequent product evaluations, owner's reports about computers and accessories, and hundreds of advertisements for computers, accessories, and software.

Computers & Electronics

Published monthly by Ziff-Davis Publishing Co., 1 Park Ave., New York, NY 10016; single issue, \$1.75; annual subscription, \$12.97.

Formerly one of the leading electronics hobbyist magazines, *Computers & Electronics*, has changed its focus to reach a broader computer-using audience. Each issue typically contains evaluations of computer hardware and software, as well as commentary about various topics of interest to computer owners. It is aimed at the intermediate to advanced level computer user who is ready to upgrade from a simple home system to a more advanced personal computer.

Creative Computing

Published monthly by Ahl Computing, Inc., a subsidiary of Ziff-Davis Publishing Co., 39 E. Hanover Ave., Morris Plains, NJ 07950; single issue, \$2.95; annual subscription, \$24.97.

Creative Computing is written for the software enthusiast, rather than the hardware-oriented computer hobbyist. Software applications covered include computer art, music, artificial intelligence, speech synthesis, games, sports simulations, puzzles, investment analysis, and others. The magazine also includes product evaluations, fiction, and social commentary.

Dr. Dobb's Journal

Published monthly by People's Computer Co., P.O. Box E, Menlo Park, CA 94026; single issue, \$2.95; annual subscription, \$25.

Dr. Dobb's Journal regularly publishes, in its own words, "joyful praise and raging complaints about vendors' products and services." In addition to product evaluations, it provides in-depth coverage of the software scene. It's definitely not a hardware-oriented magazine like

BYTE and some others, but it may be too advanced for beginners.

80 Micro

Published monthly by Wayne Green, Inc., P.O. Box 981, Farmingdale, NY 11737; single issue, \$4; annual subscription, \$36.

80 Micro is devoted entirely to users of Radio Shack's line of TRS-80 computers and accessories, but it is not published by Tandy Corp. It contains many articles and advertisements about do-it-yourself and commercial TRS-80 accessories. Despite its specialized coverage of TRS-80 computers, the magazine isn't a Radio Shack mouthpiece. *80 Micro* is a must for serious TRS-80 users.

InfoWorld

Published weekly by Computerworld Communications Inc., 375 Cochituate Rd., Box 880, Framingham, MA 01701; single issue, \$1.50; annual subscription, \$22.95.

InfoWorld, the first "newsweekly for microcomputer users," provides in-depth coverage of the personal computer world. Its articles range from features on personalities to issues of importance to microcomputer users. In every issue, it publishes a "Focus" section that addresses a single topic. This periodical has something for everyone, from the beginner to the advanced user. Its widely respected hardware and software evaluations run the gamut from professional products to games for the home computer. In late 1983, it changed from its original oversize newsprint format to a regular-size glossy newsweekly.

Interface Age

Published monthly by McPheters,

Wolfe, & Jones, P.O. Box 1234, Cerritos, CA 90701; single issue, \$2.95; annual subscription, \$21.

Interface Age is similar to *BYTE*, with technical articles on both hardware and software, but it's simpler and easier for the beginner to understand and it includes good graphics. It has fewer pages and ads than *BYTE*, but it's a good magazine for both novice and experienced computer users.

Microcomputing

Published monthly by Wayne Green, Inc., P.O. Box 981, Farmingdale, NY 11737; single issue, \$3.50; annual subscription, \$24.97.

Microcomputing is a spin-off publication from the founder of *BYTE*, and it's very similar to *BYTE*, with technical articles on hardware and software. But *Microcomputing* is better organized, making the articles easier to find. Like *BYTE*, *Microcomputing* is a must for serious computer users.

Mini-Micro Systems

Published monthly by Cahners Publishing Co., 270 St. Paul St., Denver, CO 80206; single issue, \$4; annual subscription, \$45.

Mini-Micro Systems is primarily intended for the professional who wants to stay abreast of the latest developments in small-business computer systems. Many products described, however, are also compatible with personal computers.

Nibble

Published 12 times a year by MicroSPARC, Inc., Box 325, Lincoln, MA 01773; single issue, \$3.25; annual subscription, \$26.95.

Nibble is a popular magazine among owners of Apple computers. Like *Apple Orchard*, *Nibble* isn't published by Apple Computer Inc. A typical issue contains about 200 pages, including household, entertainment, and small-business programs, tips on programming, hardware construction projects, news, and reviews of products. The contents, entirely focused on Apple computer systems, seem to provide something for both beginning and advanced Apple users.

PC: The Independent Guide to IBM Personal Computers

Published 26 times a year by Ziff-Davis Publishing Co., 1 Park Ave., New York, NY 10016; single issue, \$2.95; annual subscription, \$27.97.

PC, the original publication fostered by the IBM Personal Computer boom, has grown from under 100 pages a month to more than 500 pages. Aimed primarily at IBM-PC users, it covers a wide variety of topics useful to both the beginner and the advanced computer hobbyist. *PC* features hardware and software evaluations and detailed explanations of various technical topics. The articles are readable and useful to both the beginner and advanced user.

PC World

Published monthly (with 2 additional issues) by PC World Communications, Inc., P.O. Box 6700, Bergenfield, NJ 07621; single issue, \$3; annual subscription, \$24.

PC World contains material of interest to the novice or advanced personal computer user. Although it is primarily aimed at the IBM Personal

Computer user, its articles are of use to anyone interested in computers. The hardware and software product evaluations are of interest to anyone because many of the peripherals discussed can be used on other systems as well as the PC. From an artistic, graphics, and content standpoint, *PC World* rates high marks.

Personal Computing

Published monthly by Hayden Publishing Co., P.O. Box 2941, Boulder, CO 80321; single issue, \$3; annual subscription, \$11.97.

Personal Computing is well illustrated and easy to understand, and it gets high marks for its general contents. Aimed at personal computer users, a typical issue may include several BASIC programs, an article or two on how to make money with your computer, news about developments and products in personal computing, and sometimes fiction.

Popular Computing

Published monthly by BYTE/McGraw-Hill, P.O. Box 307, Martinsville, NJ 08836; single issue, \$2.50; annual subscription, \$12.97.

Popular Computing is a general-coverage computer magazine that emphasizes nontechnical subjects. In some respects, its content and language resemble that of *Personal Computing*. A typical issue contains articles on word processing, programming, and new products. Columns include "Ask Popular," a forum that answers readers' general questions about small computers. Other columns deal with specific applications, such as small-business computing and educational computing.

GLOSSARY

Acoustic coupler. A device that converts a computer's binary signals into audible tones, allowing the computer to send and receive information via the handset of an ordinary telephone. See Modem, Nonacoustic coupler.

Address. A specific location in a computer's memory that's used to store information. Addresses can be identified by binary numbers (machine language) or letters of the alphabet (a high-level computer language like BASIC).

ASCII code. An acronym for American Standard Code for Information Interchange. A code used to permit computers to remember and process words as well as numbers. ASCII is a binary code—a combination of 0s and 1s—for the uppercase and lowercase letters of the alphabet, the 10 digits, various punctuation marks, and other symbols.

Assembly language. A low-level computer language that replaces the binary code of machine language that a computer understands with easily remembered, shorthand-style phrases, such as CLR for "clear," CVD for "convert to decimal," etc.

BASIC. An acronym for Beginner's All-purpose Symbolic Instruction Code. An easily learned high-level computer programming language that's used to operate most personal computers.

Bit. Contraction for Binary digIT. A digital computer's smallest unit of information—either 0 or 1.

Bug. An error, defect, or problem. Software bugs are errors in pro-

grams; hardware bugs are malfunctions in equipment.

Business computer. A computer designed specifically for commercial applications. Many personal computers can be used for business applications, as well as for home applications.

Byte. A group of eight binary digits, or bits, that can indicate a number or character. One byte consists of two four-bit *nibbles*.

Cartridge. A plastic case containing one or more memory chips, which is designed to be inserted or plugged into a receptacle in a computer. A cartridge may contain a software program or may add to the computer's capabilities (such as adding memory). See also Module.

Cassette. A plastic case containing two reels on which is wound a length of 1/8-inch magnetic recording tape. Cassettes used to record audio information can also record and store computer information and programs for later use.

Central processing unit (CPU). The electronic nerve center of a computer, which commands the processing done by the computer. The CPU contains the arithmetic logic unit, as well as the control sections that retrieve program instructions from the memory, decode them, and then execute the instructions.

Chip. An integrated circuit. A tiny wafer of silicon measuring a few tenths of an inch square, on whose surface is etched and imprinted the hundreds or thousands of microscopic electronic components that comprise an integrated circuit. The

chip is enclosed in a plastic or ceramic package for protection.

Circuit. An interconnected assortment of electronic components or integrated-circuit chips that together perform some useful operation.

Clock. An electronic circuit that emits a regulated sequence of electrical pulses synchronizing the operation of the many circuits in a computer.

Code. Any of numerous methods used to represent characters of the alphabet, numbers, punctuation marks, and other symbols with binary numbers.

Computer. An electronic device that stores, retrieves, and processes information.

Conditional. A program instruction that specifies an action such as a branch, or departure, to another part of the program if a specified condition is met.

Console computer. A desktop computer with a built-in video display screen.

Control section. An important part of a central processing unit (CPU). The control section is the network of electronic circuits that retrieves, decodes, and carries out programmed instructions in a computer.

Conversational programming. A method of programming a computer using ordinary English words and phrases. BASIC and other high-level languages can be used to develop conversational programs so that the computer can respond after each statement by the user.

cps. An abbreviation for Characters Per Second.

CPU. See Central processing unit.

CRT. An abbreviation for Cathode-Ray Tube. The video display tube used in television sets, terminals, radar displays, and video monitors.

Cursor. A movable indicator on the screen of a video display that shows where the next character or symbol will appear.

Daisy wheel. A typing element, or print wheel, for an impact printer that produces fully formed, high-quality characters. The characters on the daisy wheel take the form of raised outlines at the ends of spokes extending from the element's central axis, much like the petals of a daisy.

Data. Usually refers to numerical information, but may mean any kind of information put into and retrieved from a computer. DATA is also a BASIC computer language statement that precedes one or more pieces of information in a program.

Data processing. What a computer does when it sorts, manipulates, rearranges, and otherwise processes information.

Debugging. The procedure of troubleshooting and eliminating errors in software or malfunctions in hardware.

Decision. A computer operation that compares two pieces of information or verifies a single piece of information, and then takes a specified action.

Decode. The process by which the central processing unit interprets instructions stored in a computer's memory.

Desktop computer. A computer small enough to fit on the top of a desk. Often the computer is installed inside the keyboard assembly, which is connected to a video monitor by means of a short, flexible cable.

Digital computer. An electronic system that represents numbers, symbols, and characters with binary numbers (0s and 1s) and processes such information according to a list of instructions stored in memory.

Disk. A flat, phonograph-record-like metal or plastic disk coated with a magnetic substance and used to store information; made in various sizes. Flexible plastic disks are called floppy disks or diskettes. See also Magnetic disk memory.

Disk drive. A motorized device that spins a magnetic disk at high speed. The drive contains a sensing device that can both read information from and write information onto the surface of the disk in the form of magnetized patterns.

Diskette. A floppy disk. See Floppy disk, Magnetic disk memory.

Disk memory. See Magnetic disk memory.

Documentation. Operating instructions, applications information, servicing information, programs, and other forms of software supplied with a computer or available separately.

Dot-matrix printer. See Matrix printer.

Dumb terminal. A video display unit and keyboard that can communicate with a computer, but that cannot on its own perform computer operations. See also Smart terminal.

Electronic mail. A method of transmitting information over ordinary telephone lines. Two or more computers can be used to transmit correspondence and other communications.

Erase. To remove or clear information stored in a computer's memory.

Execute. To perform a specified operation listed in a program, or to run the entire program.

Floppy disk. A flexible magnetic disk made from plastic and coated with a magnetic material on which computer information and programs can be stored. See also Magnetic disk memory.

Glitch. An unwanted and undesirable electrical pulse inside a digital computer, which can cause errors in a program. A glitch may occur because of improper design, or it may find its way into the computer via power lines or even through the airwaves.

Handheld computer. A compact computer that can be held in one hand.

Hard copy. Computer output—programs, information, results, and other data—printed on paper by a printing device connected to the computer; also called a document.

Hardware. Keyboards, video monitors, memory storage devices, cir-

cuit boards, and all other electronic circuits and physical equipment that form a computer or computer system.

High-level language. A computer language in which each instruction or statement represents several binary code instructions in machine language. High-level languages allow computer users to write in terms that are familiar to them. For example, BASIC uses English words to instruct the computer. *See also* Machine language.

IC. *See* Integrated circuit.

Impact printer. A printer that forms characters or symbols by striking a hammer or printhead against a carbon or inked ribbon and a sheet of paper. Some impact printers form a character in a single operation; others form characters from patterns of dots. *See also* Nonimpact printer.

Ink jet printer. A type of nonimpact printer that forms characters by squirting tiny jets of ink onto paper. The jets are directed by a magnetic field controlled by electronic circuits in the printer. *See also* Impact printer.

Input peripheral. Any device designed to transfer information into a computer. For example, keyboards and joysticks are input peripherals. *See also* Output peripheral.

Instruction set. The collection of various instructions that a particular computer can understand.

Integrated circuit (IC). A microminiature electronic circuit that's imprinted and etched on the surface of a silicon chip. *See also* Chip.

Interface. The linkage between two parts of a computer or between a computer and an accessory.

Interrupt. A temporary and often brief interruption in the execution of a program so that a digital computer can handle or service an external event such as the printing of a character.

Joystick. A movable shaft that permits positional information to be transferred into a computer. Used most often to move animated figures and missiles around the screen during computer games, joysticks have more serious roles as well. For example, a joystick can be used to move

an arrow or marker around the screen of a computer to assist in editing a program or designing graphics patterns.

K. Abbreviation for Kilobyte. A common way of describing the memory capability of a computer. K is derived from the prefix *kilo-* and means approximately 1000 information units. An exact definition of K is 2^{10} or 1024 bytes. Therefore, an 8K computer memory can store 8192 bytes of information.

Keyboard. An array of keys, buttons or switches that permit instructions and numerical information to be manually entered into a computer.

Language. An organized system of words, phrases, symbols, characters, and numbers that permits a computer operator to communicate with the computer and give it instructions. *See also* Assembly language, BASIC.

Light pen. A pen-like device, containing a light-sensitive cell at the tip. When pointed toward a video display screen, a light pen allows the computer to compute the location and know precisely where the pen is being aimed. The light pen can be used to draw or make selections on the video screen.

Line. A line of information in a computer program.

Line printer. A type of impact or nonimpact printer that produces a complete line of print in one high-speed operation.

Loop. A sequence of one or more computer instructions in a program that are executed repeatedly until one or more specified conditions have been met.

Machine language. A computer's language of binary numbers (0s and 1s); the internal binary language into which a more advanced programming language must be converted before a computer can process a program.

Magnetic bubble memory. A specialized solid-state memory (made from high-density semiconductors) that stores information in the form of microscopic magnetic regions on a thin wafer of garnet. When viewed through a special microscope, the magnetic regions resemble bubbles.

These regions can be moved through the crystal in which they're formed by means of a magnetic field.

Magnetic disk memory. A form of computer memory that records binary information on disks of various diameters, made of metal or plastic and coated with a magnetized substance. Information is read from and written on the magnetic surface of the disk with a recording head similar to those used in tape recorders.

Magnetic tape memory. A form of computer memory that records binary information on magnetic recording tape.

Mass storage media. Material (such as magnetic tapes and disks) that store enormous quantities of information in a relatively small space.

Matrix printer. A printer that forms characters from patterns of closely spaced dots.

Memory. The circuits, components, or mechanical portions of a computer that store information.

Menu. A list of choices displayed by a computer program, from which the user may select an option.

Micro. A microcomputer.

Microcomputer. A computer that uses a microprocessor for a central processing unit. Nearly all personal computers are microcomputers. *See also* Microprocessor, Central processing unit.

Microflop. A floppy disk that is about 3 to 3½ inches in diameter. *See also* Floppy disk, Magnetic disk memory.

Microprocessor. A tiny integrated circuit that contains the complete central processing unit for a computer. A microcomputer is made by connecting a memory integrated circuit to a microprocessor. *See also* Chip.

Miniflop. A floppy disk that is about 5¼ inches in diameter. *See also* Floppy disk, Magnetic disk memory.

Modem. An acronym for MOdulator-DEModulator. A device that permits computers to communicate with one another over telephone lines. *See also* Acoustic coupler, Nonacoustic coupler.

Module. A plastic case with one or more memory chips, designed to be inserted or plugged into a receptacle in a computer. *See also* Cartridge.

Mouse. A specialized input device that allows the user to move the cursor or another figure around the screen without using the keyboard.

Music synthesizer. An electronic circuit that can synthesize (create) musical sounds. Some personal computers can be programmed to simulate the operation of a music synthesizer.

Network. An arrangement for interconnecting a number of computers by telephone lines or other direct means (such as cables).

Nibble. A common reference to a binary number or word composed of four bits; half a byte. *See also* Bit, Byte.

Nonacoustic coupler. A device that connects a computer directly to a telephone line. It converts a computer's binary signals into audible tones to allow the computer to send and receive information via a telephone line. *See also* Modem.

Nonimpact printer. A printer that forms characters without striking a carbon or inked ribbon against paper. For example, the thermal printer is a nonimpact printer that forms characters by forming patterns of dots on heat-sensitive paper. Nonimpact printers are much quieter than the impact variety. *See also* Impact printer, Ink jet printer.

Nonvolatile. A term used in reference to computer memory that stores information with or without electrical power. When the electrical power is turned off, the information stored is not lost. Common examples of nonvolatile memory include magnetic tape and disks.

Output peripheral. Any device designed to receive information or signals from a computer. Video monitors and printers are common output peripherals. *See also* Input peripheral.

Peripheral. Any input or output device designed to be connected to a computer.

Personal computer. A microcomputer equipped with an input mecha-

nism such as a typewriter-like keyboard and an output device such as a video monitor or printer.

Plotter. A device that produces an inked drawing of graphics patterns or text or both. The pen that makes the drawing is moved across paper by means of a motor-and-pulley arrangement controlled by the computer.

Power supply. The electronic circuits that convert power from an electrical outlet into a form suitable for use by a computer.

Printer. A device that prints programs, results of programs, and other information on either individual sheets or continuous strips of paper. *Impact printers* print by striking an embossed mechanism or array of pins against a carbon or inked ribbon next to the paper. *Nonimpact printers* print by applying heat or electricity to specially prepared papers.

Program. The set or list of instructions that directs a computer what to do and how to do it. *See also* Software.

RAM. An acronym for Random-Access Memory. *See* Random-access memory.

Random-access memory (RAM). Computer memory, often a solid-state integrated circuit, that stores and recalls information in any order or sequence. Unlike read-only memory (ROM), RAM requires electrical power to remember information; turn off the power and the information is lost. *See also* Read-only memory.

Read. The process of retrieving information from a circuit, memory chip, punched tape, or magnetic tape or disk.

Read-only memory (ROM). Computer memory, often a solid-state integrated circuit, that stores permanent information that cannot be erased, changed, or lost even if electrical power is turned off. *See also* Random-access memory.

Read-write memory. A form of computer memory (such as magnetic tape or a disk) used to store information, or an integrated circuit whose contents can be erased and changed. Because semiconductor read-write memories are random-access devices,

they are often called RAMs. *See* Random-access memory.

RF modulator. An electronic circuit that permits a computer to be connected directly to an ordinary television set to provide a video display.

ROM. An acronym for Read-Only Memory. *See* Read-only memory.

Run. To begin the execution of a computer program.

Semiconductor. The crystalline substance used to make memory chips, microcomputer chips, and other integrated circuits. The most common semiconductor for these purposes is silicon, the principal ingredient of ordinary beach sand. *See* Chip, Integrated circuit.

Smart terminal. A keyboard and video display assembly that's capable of performing computer-like operations. Its primary role, however, is communicating with a true computer. *See also* Dumb terminal.

Software. A collective term for programs, lists, operating instructions, and other documentation associated with the operation of a computer.

Solid-state. A reference to electronic components or complete circuits made from silicon, germanium, or other solid substances.

Statement. A line or command in a computer program; for example, PRINT A.

Store. To remember a piece of information.

Subroutine. One or more sequential instructions in a computer program that are ordinarily used more than once by the program. Subroutines may be as brief as several lines or they may be considerably longer than the main program that includes them.

Terminal. An input or output device connected to a computer, which is capable of sending and receiving information. A terminal is usually an input device like a keyboard and an output device such as a video display unit or a printer.

Thermal printer. A nonimpact printer that forms characters by making blue or black dots on heat-

sensitive paper. The paper contains tiny microcapsules of ink that are burst open by heat from the thermal heating elements of the print mechanism.

Variable. In the BASIC computer language, a variable is a letter of the alphabet assigned to a memory location that can contain any designated number.

VDI. An abbreviation for Video Display Terminal. *See also* CRT.

Video graphics. Diagrams, charts, graphs, figures, drawings, and patterns formed on a video screen. Computers with considerable memory can produce moving graphics patterns. Graphics have many recreational applications, but they were originally

developed and are still used for commercial applications.

Video monitor. The television-like device on which computer information in the form of text or graphics is displayed on a screen.

Voice synthesizer. An electronic circuit that simulates the human voice.

Volatile. A term used in reference to computer memory that requires electrical power to retain information. Most RAMs used in personal computers are volatile; turn off the electrical power to the computer and any information in the RAM is lost.

Word. A common reference to a sequence of bits, often an 8-bit byte, that represents a number, symbol, let-

ter of the alphabet, or program instruction. Personal computer words are usually 8 bits in length. Some newer computers use 16-bit words (two bytes).

Word processing. A method of using a computer as an electronic typewriter with a built-in memory. Word processing speeds up the preparation of error-free text. It also permits efficient editing, the storage on magnetic disks of correspondence and other information, and simplified preparation of mailing lists.

Word processor. An automated, computer-based system for producing typed documents.

Write. To store information in a memory chip, on a punched tape, or on a magnetic tape or disk.

INDEX

A

- Acoustic coupler, 44
- Adam, 53–54
- A/D (analog/digital) converters, 18
- Apple, 51–52
 - Apple Lisa, 52
 - Apple IIe, 51
 - Apple III Plus, 52
- Applications software programs, 24
- Artificial intelligence, 87
- Assembly language, 23
- Atari, 52–53
 - 600XL, 52
 - 800XL, 53
 - 1400XL, 53
 - 1450XLD, 53

B

- Backup power supply, 46
- BASIC, 23–24, 67–80
- Binary numbering system, 13, 22
- Bit (binary digit), 13
- Bootstrap programs, 16
- Bubble memory, 85–86
- Business software, 10, 29–30
- Business uses of personal computers, 9, 10, 29
- Byte, definition of, 14

C

- Cartridge, plug-in, 27–28
- Cassette tape, 25–26
- Cassette tape recorders, 25, 34
- Chiclet keyboard, 17
- COBOL, 23
- Coleco, 53–54
- Commodore, 54–55
 - Model 64, 54–55
 - PET, 54
 - SuperPet, 55
 - VIC 20, 54
- CompuServe, 10, 86
- Computer
 - building your own, 66
 - buying used, 64–65
 - campus, 11
 - clubs, 11
 - cost of, 5, 7

- definition of, 5
- educational uses, 78–79
- factors in purchasing, 49–51
- future uses of, 82–87
- games, 9, 28
- handheld, 61–62
- home uses of, 6
- languages, 13, 22–23
- model descriptions, 51–62
 - Apple Lisa, 52
 - Apple IIe, 51
 - Apple III Plus, 52
 - Atari 600XL, 52
 - Atari 800XL, 53
 - Atari 1400XL, 53
 - Atari 1450XLD, 53
 - Coleco, 53–54
 - Commodore PET, 54
 - Comodore 64, 54–55
 - Commodore SuperPet, 55
 - Commodore VIC 20, 54
 - Epson HX-20, 61
 - Epson QX-10, 55
 - IBM compatibles, 57
 - IBM PCjr, 56–57
 - IBM Personal Computer, 55
 - IBM Personal Computer XT, 57
 - KayPro II, 60–61
 - Quasar/Panasonic HHC, 61
 - Radio Shack MC-10, 57
 - Radio Shack Model 12, 59
 - Radio Shack Model 16B, 59
 - Radio Shack Model 100, 61
 - Radio Shack TRS-80 Color Computers, 58
 - Radio Shack TRS-80 Model 4, 58
 - Texas Instruments CC-40, 61
 - Timex Sinclair 1000, 59
 - Timex Sinclair 1500, 59
 - Timex Sinclair 2068, 59
- types of, 5
- where to buy, 62–65
- Conversational programming, 74
- Copy protection, 32
- CP/M (Control Program for Microcomputers), 25
- CRT (cathode ray tube), 19
 - See also Video display

D

- Daisy wheel printers, 38
- Data, 5
- Database managers, 29, 30
- Databases, 10–11
- Debugging, definition of, 24
- Desktop computers, 6, 51–60
 - See also Computer, model descriptions
- Direct-connect modem, 44
- Disk
 - floppy, 26–27, 35–36
 - hard, 27, 37
 - optical, 86
- Disk drive controller, 35
- Disk drives, 34–37
- Disk operating system, 24, 35
- Documentation, 50
- DOS (Disk Operating System), 24, 35
- Dot-matrix printers, 39–40
- Dow Jones News/Retrieval Service, 10, 86

E

- Educational software, 29
- Education and computers, 8, 78–79
- Electronic mail, 10, 87
- Electronic spreadsheet, 30
- Epson HX-20, 61
- Epson QX-10, 55
- Expandability, 15, 46–47
- External mass storage, 14

F

- File, 26, 27
- Floppy disks, 26–27
- FORTRAN, 23

G

- Game paddles, 18, 43
- Games, 9, 28
- Graphics keys, 17

H

- Handheld (pocket) computers, 7, 61–62
- Hard copy, 37
- Hard disk drives, 27, 37

Hard disks, 27, 37
Hardware, 5, 12–20
Heath Company, 66
High-level language, 23
 See also Computer, languages
Home computer, 6
Household finances and computers,
 8, 29
Household software, 29

I
IBM compatibles, 57
IBM PCjr, 56–57
IBM Personal Computer, 55–56
IBM Personal Computer XT, 57
Impact printers, 38–40
Ink jet printers, 40
Input, 5
Input devices, 16–18
 See also Peripherals
Input/output devices, 20
Interfaces, 42
Investments and computers, 10

J
Joystick, 18, 43

K
K, definition of, 15
KayPro II, 60
Keyboard, 17–18, 50

L
Languages, computer, 13, 22–23
Letter-quality printers, 38
Light pens, 18, 45
Line filter, 46
Loading, 22
Loop, 72, 73

M
Machine language, 22
Magnetic bubble memory, 85–86
Magnetic media, 25
 See also Cassette tape; Disk
Mail-order buying, 63–64
Mainframe computers, 5
Manufacturers
 back-up policies, 32
 reputation, 51
Mass storage, 85
Membrane keyboard, 17
Memory, 5, 14–16, 50
 bubble, 85–86
 expansion, 15, 46–47
 future developments, 85–86
Microcomputer, 5, 6
 See also Computer
Microprocessor, 5, 13–14, 82, 85
Modem, 10, 44
Monitor
 See Video display

Mouse, 18
MS-DOS, 25

N
Network, 86–87
Nibble, definition of, 14
Nonvolatile memory, 15

O
Operating system, 24–25
Optical disks, 86
Output, 5
Output devices, 18–20

P
Panasonic
 See Quasar/Panasonic
Parallel interfaces, 42
Pascal, 23
PC-DOS, 25
Peripherals, 7, 13, 33–47, 50
 See also A/D converters; Cassette
 tape recorders; Disk drives;
 Joystick; Light pens; Memory,
 expansion; Modem; Plotter;
 Power protectors; Printers
Personal computer, definition of, 6
Piracy, software, 32
Plotter, 46
Pocket computers, 61–62
Portable computers, 7, 60–62
Power protectors, 46
Printers, 20, 37–43
 dot-matrix, 39–40
 factors in choosing, 41–43
 graphic, 42
 impact, 38–40
 interfaces, 42
 letter-quality, 38
 nonimpact, 40–41
 paper feed mechanisms, 41
Processor, 5
Professional computer, 6
Program, 22
Programming, 67–80, 84–85
 conversational, 74
 languages, 13, 22–23

Q
Quasar/Panasonic
 HHC, 61–62

R
Radio Shack, 57–59, 61
 MC-10, 57
 Model 12, 59
 Model 16B, 59
 Model 100, 61
 TRS-80 Color Computers, 58
 TRS-80 Model 4, 58

RAM (random-access memory),
 14–16, 50
RF modulator, 19
ROM (read-only memory), 16, 50
Run, definition of, 70, 80

S
Serial interfaces, 42
Software, 13, 21–32, 50
 business, 10, 29
 educational, 29
 free copies of, 31
 games, 28
 household, 29
 how to buy, 30
 media, 25–28
 piracy of, 32
 prices of, 30
 types of, 28–32
 word processing, 30
Source, The, 10, 86
Speech synthesis, 20, 84

T
Telecomputing, 10–11
 See also Modem; Network
Terminals, 20, 44–45
Texas Instruments, 61
 CC-40, 61
Thermal printers, 39–40
Thimble wheel, 38
Timer, 73
Timex Sinclair, 59
 1000, 59
 1500, 59
 2068, 59
Trackball, 18, 44

U
Uninterruptable power supply (UPS),
 46
Universal Product Code (UPC), 25
UNIX, 25
Used computers, 64–65
User-friendliness, 11, 83
Users' groups, 11

V
Variables, 72
VDT. *See* Video display
Video display, 19
 factors in selecting, 50
Video monitor, 19
Voice recognition, 18, 84
Voice synthesis, 20, 84
Volatile memory, 15
 See also RAM

W
Warranties, 42, 50–51
Winchester disk drives, 37
Word processing, 9, 30, 75–76

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